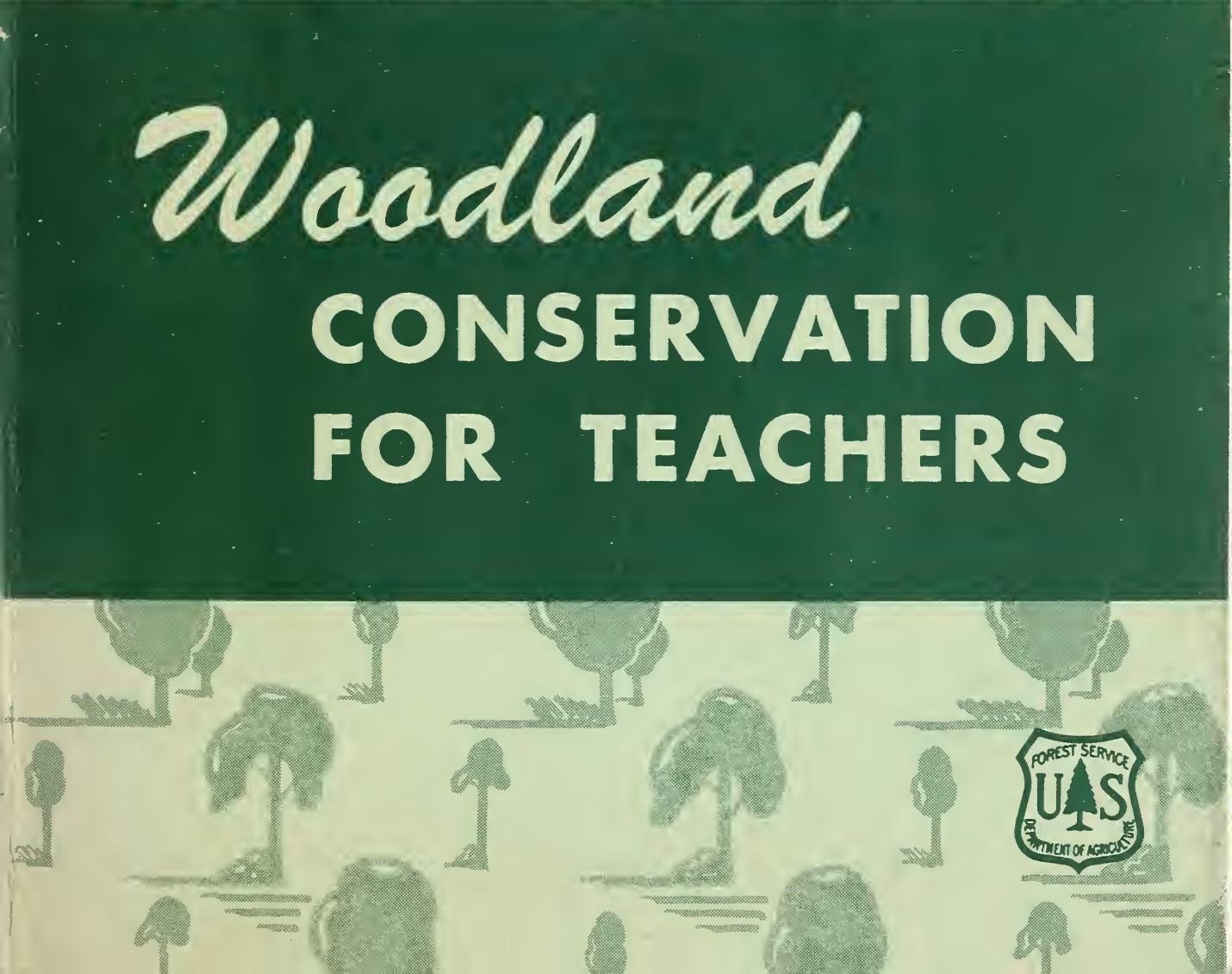
Woodland
CONSERVATION FOR TEACHERS



WOODLAND CONSERVATION FOR TEACHERS

in Iowa, Illinois, Indiana, and Ohio

By

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FOREWORD

The future of conservation rests with the teachers of this country more than with any other single group. Theirs is the opportunity of presenting the importance of natural resources to generations who will have ever-increasing problems to solve in managing them, but who — it is to be hoped — will also enjoy ever-increasing benefits from their use.

The content of this publication is directed toward the renewable natural resources in the woodlands of Iowa, Illinois, Indiana, and Ohio. These states all have somewhat similar forest conditions. About half the booklet is devoted to various aspects of woodland management, half to inter-relationships of vegetation, soil, water, wildlife, and man. Throughout, the viewpoint is realistic, in terms of central states' species, conditions, and recognizable community problems.

The material is presented primarily to meet the needs of the teacher whose background is in the arts and social sciences, and is therefore non-technical in its approach, yet it is our hope that teachers with background in natural and physical science will discover new material, or familiar subject matter interpreted with a new conservation meaning. The booklet is designed to provide teachers with substance for developing their own instruction units.

The importance of woodlands in these 4 states is not to be reckoned in terms of area alone. Some of the most valuable tree species, chiefly hardwoods, are to be found here. They have great potential value, but public recognition and owner knowledge about them is far less than commensurate.

The woodlands over much of the region occur in small tracts that are often neglected or at best regarded merely as adjuncts to the farms of which they might well be an integral part. Even where continuous expanses of woodland are found, they are broken up into small ownerships that make consistently acceptable forest practices difficult. It is our hope that this booklet will help teachers in the region to create a better understanding of these and other central woodlands and of what can be done to improve them.

H. Dean Cochrane

Regional Forester

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ACKNOWLEDGEMENTS

This publication combines organization of information already published in reports and bulletins with a synthesis of opinion and some original interpretations.

Material from a variety of sources has been drawn upon, including reports and bulletins of the conservation departments of Iowa, Illinois, Indiana, and Ohio; and several publications of the Central States Forest Experiment Station of the U.S. Forest Service. Data from the Forest Survey were liberally used in the chapter on Timber Resources.

Thanks are due all those who reviewed and criticized the manuscript in Forest Service offices in Milwaukee, Wis., St. Paul, Minn., Columbus, Ohio, and Washington, D.C. All were very helpful, particularly Leon S. Minckler of the Forest Service's research center at Carbondale, Illinois. Harlow B. Mills of the Illinois Natural History Survey, kindly furnished assistance in the chapter on wildlife habitat.

All photographs are from the U.S. Forest Service, and nearly all of them were taken in the 4-state area that is covered.

Milwaukee, Wisconsin — CHARLES E. FOX

June 1, 1955

1

THE CENTRAL REGION

Six broad forest regions are commonly recognized for the United States: Pacific Coast, Rocky Mountain, Southern, Tropical, Northern, and Central. The 4 states with which we are chiefly concerned in this book — Iowa, Illinois, Indiana, and Ohio — are in the Central Forest Region that extends across the middle of eastern United States from the prairie of the Great Plains nearly to the Atlantic Coast.

Before 1800 there was probably a good deal of truth in the observation that "a squirrel could travel from the Ohio River to the Great Lakes without touching the ground." But the settlers came and the seemingly endless forest was pushed back. Settlers and farmers clearcut and burned to rid the land of trees so that the soil might be tilled. The process of removing the forest was carried on in small-scale operations, but it was widespread, and it was persistent. During the period of busy construction when the farms and cities of the Midwest were being built, the conifers of the North instead of the local hardwoods were in demand.[1] As a result there were few large lumbering operations in the central region resembling those that swept through the Lake states in the late 1800's, and the lumberjack never attained the stature of a legendary figure.

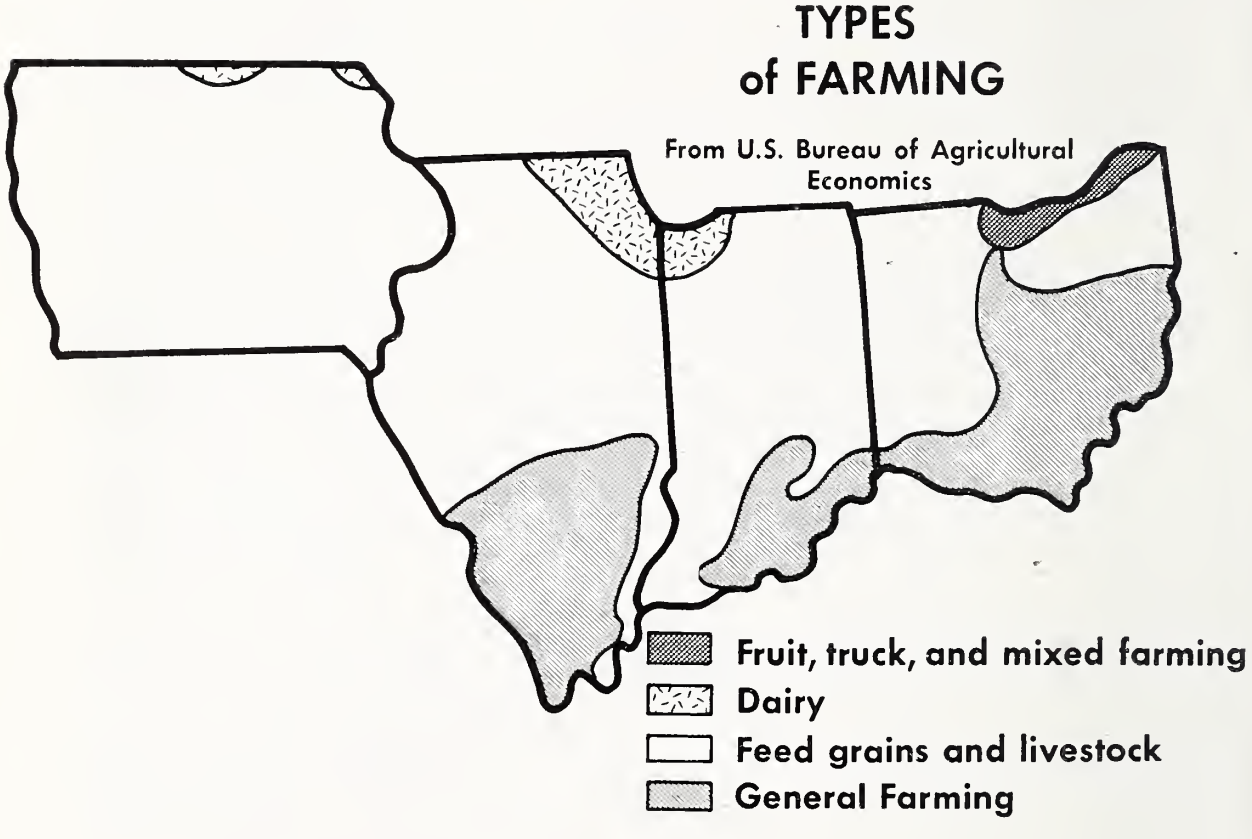
Now only vestiges of the virgin forest exist. Of the total area originally in forest, about ¼ remains. Repeated burning, heavy and prolonged grazing by livestock, and cutting concentrated on the best trees and the most valuable species have depreciated the quality of the existing forest. Nevertheless, in the 4 states, woodland predominates on nearly 16 million acres. With approximately one acre in every 8 consisting of woods, it is obvious that woodland is today an important resource in the central states.

The region offers a vast local market for wood products. There are 24 million persons in the 4 states, creating a population density exceeded only by the Atlantic seaboard. Industrial centers, great cities, and intensively-developed farms produce a demand for large

[1] For explanation of terms "conifers" and "hardwoods" see Appendix, page 117.

quantities of lumber and wood products. Only a small part of this demand is supplied from local hardwoods however, coniferous (softwood) lumber being preferred for its easy workability and other qualities. Most of the region's timber supplies come from the Pacific Coast and the South.

The central area is heavily populated and highly developed. Practically all woodland of commercial importance is owned by farmers. Iowa is predominantly a rural state, with more people living on farms than in cities. Excluding the metropolitan centers, Illinois and Indiana are also essentially rural in character. Ohio has a larger urban population, well distributed, but also an extensive area of farm woodland. The principal types of farming are general farming, dairying, and, in the corn belt, feed grains and livestock.



Most of the land is flat or slightly undulating, but there is considerable hilly country. The rougher areas, as might be expected, support some of the heaviest timber stands[1] as in eastern and southern Ohio, southern Indiana and Illinois, and northeastern and southwestern Iowa. River bottoms are frequently well timbered.

[1] Stand: a common term for a group of trees with like characteristics — a "young stand," a "stand of oak," a "sawtimber stand," a "healthy stand."

Large blocks of forest land still exist in parts of the central region.

Climate is moderate except for occasional extended droughts which damage or kill trees. Data showing approximate annual averages comparing northern and southern portions of the 4-state region are given in the following table:

	NORTH	SOUTH
Temperature, average annual	45 degrees F.	55 degrees F.
Temperature, average maximum	100 degrees F.	100 degrees F.
Temperature, average minimum	—20 degrees F.	—5 degrees F.
Precipitation	30 inches	45 inches
Fall of snow, total	30 inches	15 inches
Frost-free period	160 days	180 days
Elevation	1675 feet, NW. Iowa (highest)	279 feet, Mississippi R., Ill. (lowest)

About 16 million acres of woodland, corresponding to the area of West Virginia, remain in the central region out of an original forest area of 65 million acres. Continuous stands of timber once flourished throughout Ohio, Indiana, southern Illinois, eastern Iowa, and along river bottoms. Even the prairie lands of Illinois and Iowa supported stands of fine timber in scattered woodlands and along every watercourse. Our land will grow timber, as demonstrated by the original cover. And 16 million acres will produce a lot of timber, if protection is provided and some attention is given

to management. Unfortunately, however, 4/5 of the present forest area is practically without management.

Management is practiced on few privately-owned woodlands. This photograph was taken immediately after logging for sawtimber was completed. Too many small trees were removed. It will be many years before another cutting can be made on this area. Waste and breakage are evident; trees of poor form should have been removed, also the tree at extreme left with bad scar.

Conditions are favorable for rapid growth of timber. Shortleaf pine planted only 15 years ago has already been harvested for pulpwood and fence posts, providing cash income. In the Lake States 120 years would be required in a managed stand for growing timber to large size for lumber and veneer, yet it can be grown in the central states in 85 years.

What can be done to restore the productivity of our timberlands? How can good forests help safeguard water supplies, provide vacationlands, improve wildlife conditions, make our environment more pleasant? The following pages are devoted to finding the answers to these questions. One can better appreciate the forest's multiple benefits by first understanding what a woodland is and how it functions. The soil under a woodland is a good place to start.

2

WOODLAND SOIL

How Woodland Soil Is Formed

The interactions of soil, water, animals, and vegetation of a woodland result in a biological community which can perform functions denied to simpler communities. The soil in a woodland is different from other kinds of soil and its distinctive nature makes certain functions possible.

Formation of soil from weathering of parent rocks may require from a few hundred years to several million, depending upon such factors as climate, nature of the parent material, activity of organisms[1] and direction and degree of landslope. Soil formation in the later-affected portions of our glacial areas began after the ice receded, 18-25,000 years ago in the south and 10-12,000 years ago in the Great Lakes area.

Weathering causes physical disintegration and chemical decomposition in rocks and minerals. The action of heat, cold, rain, snow, ice, wind, water, and alternate freezing and thawing, break down the rock into particles. Roots penetrate, insects and worms burrow and tunnel, and air spaces are created. The presence of water permits chemical changes to take place; simpler mineral compounds in solution are made available for plants, and thus ultimately for animals. Plants die; their stems, fruits, roots, and leaves decompose, and along with the remains of animals large and small, contribute organic matter to the soil.[2] Biological processes as well as weathering therefore build soil. Soils pass through a development period the same as plants and animals. Some soils are young, some are very old.

About 1½ to 3 tons of litter[3] per acre are deposited each year on the forest floor by timber stands in the central states. The

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[1] Organism: Something alive, or alive at one time.

[2] Organic matter: living or once-living substance.

[3] Litter: debris of plants — dead grass, leaves, branches, bits of bark, fallen trees, etc.

total accumulation of litter generally amounts to 6 to 12 tons per acre.

Freshly-deposited organic debris is attacked by water, air, plant enzymes, animals, and a variety of micro-organisms, the latter probably the most important of all. Fungi that cause rot attack the woody material, assisted by termites, ants, insect larvae, earthworms, millipedes, and mites. Dead roots and rootlets are consumed. That the result is exceedingly fine porous material, well aerated, can be understood by considering that many of the chewing animals are only 1/250 of an inch broad, producing burrows and tunnels only 1/25 of an inch in diameter. Counts have shown as many as 5,000 individual organisms of these types to a cubic foot of woodland soil, and as many as 70 different species have been collected from less than a square foot.

Organic matter in the soil, then, is composed of dead plant parts, including roots, leaves, fruits, and stems; dead insects, worms, and other animals; live and dead bacteria, fungi, and protozoa; various products of the decomposition process, and active micro-organisms. Excluding litter, the amount of organic matter in woodland soil may vary from 20 to 50 tons per acre. There is probably no soil strictly without organic matter since some forms of living or once-living things are present in any rock material that has disintegrated. Many desert soils contain less than one percent organic matter, whereas some bog soils are almost 100 percent organic.

Characteristics of Woodland Soil

Plant and animal material of the forest floor which is undergoing evident decomposition is known as *humus.* Organic debris decomposes at various rates, and humus represents intermediate stages in the decomposition process. Humus is a dark-colored, practically odorless substance, and has no distinct chemical composition, so far as we know. It is porous, containing relatively large amounts of air and weighing little for its volume. Humus represents a storehouse of energy. Its byproducts act on mineral nutrients and gradually make them available to plants in a form that they can use. Equally important, the presence of humus greatly influences the color, structure, and consistency or "feel" of a soil, providing qualities important to the growth of vegetation and to the disposal of water from rain or snowmelt.

This tree was cut before the Civil War. With the help of weathering and the action of plants and animals it is being reduced to organic matter of the forest floor — a stage in the transformation of a living thing into soil.

The largest concentration of humus is found at the surface since that is where plant and animal deposits are heaviest. In our central woodlands there is little humus in soil below the top 3 inches or so and there is a gradual decrease downward. As organic matter is present, the surface layers are fertile. Roots are numerous because food elements are abundant. Roots tend to hold soil in place, and when they are present woodland soils do not erode (wear away) readily. Roots help to keep woodland soil loose and porous, and aid the penetration of surface water.

The content and volume of humus produced depend upon principally 2 factors: character of the living matter from which it is derived, and rate of its decomposition. One reason for abundant crop yields on soils formerly in prairie is the tendency for grass to develop a relatively large content of humus. This is not so much due to the contribution of stems and leaves as in the forest, since the volume above ground in the case of grasses obviously is small. Instead, it is chiefly due to the large volume of roots, which die, decompose, and remain in place.

Humus decomposes rapidly in the central region due to high summer temperatures. Combine this factor with abundant rainfall which leaches (washes) soluble minerals to deeper soil, and the result is a comparatively shallow humus layer at the surface. The addition of fresh organic litter approximately balances decomposition and subsequent loss by leaching, thus neutralizing the tendency to build up a thick humus layer.

Litter in the northern coniferous forest, however, decomposes slowly because of low temperatures, short growing season, and more moderate precipitation. This results in a mat of raw humus several inches thick, and peat in beds up to 5 feet in depth. A line of demarcation is usually distinct between raw humus and mineral soil below. Sometimes the mat can be rolled back or peeled off. In our central hardwoods, on the other hand, the organic and mineral components of the soil are generally well mixed. Here we speak of the crumbly humus layer as *leafmold.*

Plants obtain water and dissolved mineral elements from the soil. These inorganic materials are miraculously transformed by the plant into living substance. Eventually this is deposited upon the surface of the soil, and decomposed into simple compounds such as water, carbon dioxide, free nitrogen, ammonia, methane, and various mineral salts. When these products are again taken up in liquid form through the roots, the cycle of plant material to soil material and back to plant material is complete.

Woodland litter. Litter builds soil and protects it.

The element most critical to soil fertility is probably nitrogen. High temperatures and humid conditions in the central region tend to lower nitrogen content in soils. This is a result of rapid decomposition, and excessive leaching which washes nitrates and other compounds into the lower soil depths out of reach of plant roots. Many of our soils, particularly in hilly country, are easily depleted of nitrogen by relatively slight removals of topsoil[1] which result from fire, grazing, cultivation, landclearing, or road construction.

An acre of corn on good soil is said to give off more than 25 times as much carbon dioxide as an adult man at work. On a warm July day a 40-acre cornfield oxidizing organic matter in the soil would produce energy equivalent to that of a 40-horsepower steam engine. A 40-acre woodland oxidizes organic matter at a much more rapid rate. It returns, however, an equivalent amount of energy to the soil in the form of perhaps 100 tons of litter per year, while corn may return very little. In contrast to corn, therefore, which must be rotated with other crops or fertilized, or both, the woodland is self-renovating.

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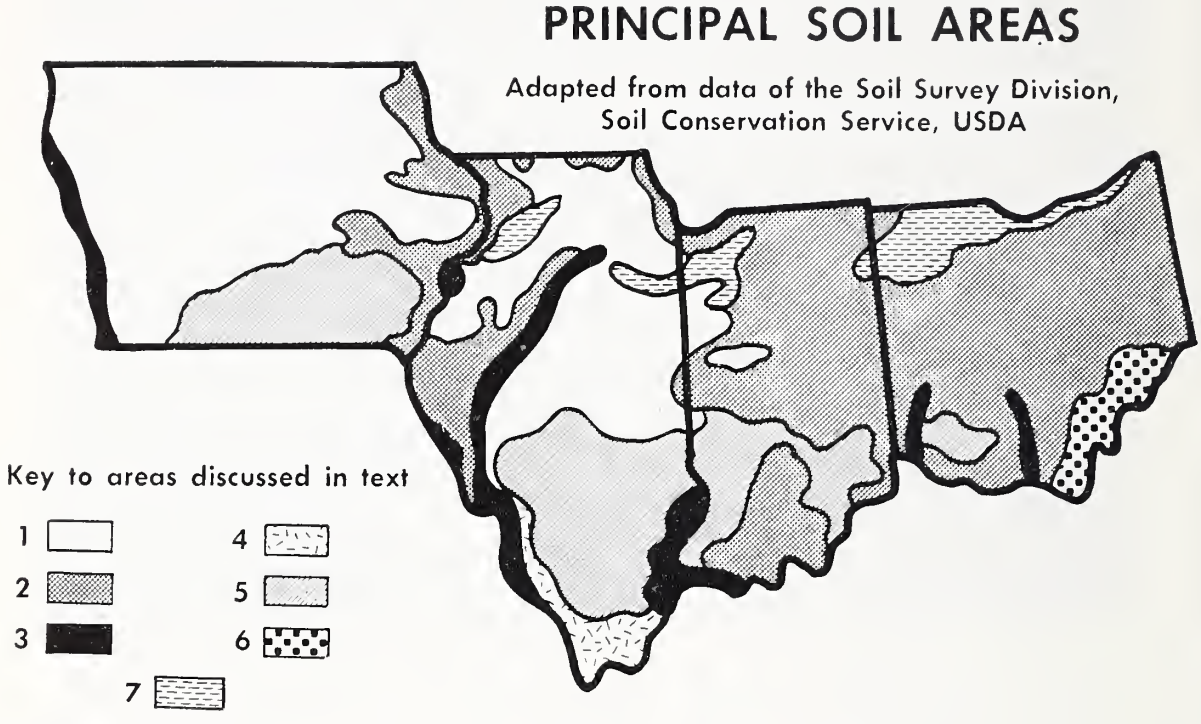
[1] Topsoil: the upper soil immediately below the surface as contrasted with the subsoil farther down.

Principal Soil Areas

The principal soil areas found in the central region are shown on the map below.



These areas, as numbered on the map, might be characterized as follows:

1. Very dark brown soils which developed under grasses predominate in this area. The climate is cool and humid. Some extensive lowlands occur, and in these situations brown or black soils, which developed under conditions of poor drainage, are found. In some places along the major streams, grayish-brown, leached soils which developed under forest vegetation are also found.
2. Grayish-brown, leached soils which developed under forest vegetation predominate in this area. The climate is temperate and humid.
3. Alluvial soils predominate in Area 3. They are developing from recently deposited materials which have had little or no modification by processes of soil formation. Also included are rather extensive sections in which soils are developing under forest or grass vegetation with varying degrees of natural drainage.
4. The most extensive soils of this area are the red or yellow, leached soils which developed under forest vegetation. The climate is warm-temperate and humid.

5. The dominant soils here have strongly-leached surface horizons over claypans. They occur on nearly flat topography in cool to warm, humid to subhumid conditions under forest or grass vegetation. In parts of this area there are sections having very dark brown soils, developed under grass, such as those predominating in Area 1.
6. Shallow soils consisting largely of an imperfectly-weathered mass of rock fragments predominate in Area 6.
7. The soils of this area developed under conditions of imperfect to very poor natural drainage. They include:
   a. The dark brown to black soils which developed with poor drainage under grasses in humid and subhumid sections.
   b. Gray, sandy soils (with brown, cemented, sandy subsoils) which developed in a humid climate under forest vegetation on nearly level topography. Natural drainage is imperfect.
   c. Very poorly drained, shallow, dark-colored, peat or muck soils formed in humid conditions under swamp-forest vegetation and underlain by gray mineral soil.

The largest solid blocks of forest today remain on Areas 3, 4, and 6. In general, Areas 5 and 7 are quite heavily wooded, and small, scattered farm woodlands are found in Areas 1 and 2.

Land-Use Practices

Thousands of acres of forest in the hills of southern Ohio, Indiana, and Illinois were converted to cropland by cutting and burning. On many such farms the reserves of fertility built up by the forest were quickly exploited. Topsoil was lost and crop yields diminished on the improverished soil. Living conditions became submarginal and many farms were abandoned. Some of this land is still on a rotation of cropland — open pasture — woodland — reclearing for cropland. The shifts seem to depend upon the need for land, comparative prices and profits, and opportunity for farmers to obtain other employment. Unfortunately, timber forests cannot be developed on such a rotation, although weed forests will thrive.

The soils of our woodlands have not as yet been improved using the intensive methods employed for farm crops — "plowing under," applications of fertilizers and lime, etc. Instead, woodland soil is improved by managing the plant cover.

Cover management involves *protection* — from fire, insects, disease, animals, and destructive cutting; and *treatment* to control the density of stocking and the species composition of stands. This is discussed more fully later.

Any action which unduly exposes soil, such as fire, overgrazing, landclearing, or strip mining, sets back forest development to a point where several years are required to reestablish conditions under which litter is again deposited at a satisfactory rate.

Fire is running through the accumulated litter on the floor of this woodland, consuming debris that would have eventually become incorporated in the topsoil.

Although plant cover readily becomes established on denuded (bared) forest land, except where soil loss has been great, brush and weed trees such as sassafras usually predominate. Starting with denuded land, a hundred years or more might be required for a forest of desirable species to develop naturally. If a high-quality forest is to be produced without resorting to planting, seed sources must be available either from seed trees or from dormant seeds in the soil, and seedbed conditions must be favorable. The margins between valuable land, low-value land, and damage-causing land[1] are indeed slim in many woodlands in our region. Perhaps the criterion of use by man should be that any practice which interrupts the continuous addition of litter will be considered detrimental.

[1] "Damage-causing" because of rapid runoff, deposit of sediment, etc.

This gully started as a result of overgrazing. Now it is in a stage of active erosion. "X" indicates tree dislodged by rushing waters.

Soil, then, influences the growth of woodlands. It may be fertile or sterile, shallow or deep, compacted or porous. Soil determines to a large extent what plant species will be present, how well they will grow, and whether the woodland will be a valuable one. Soil is an important and integral part of the plant-soil-water-animal structure we call a woodland.

3

FOREST WATERSHEDS

Water Problems

Our 4-state area, like nearly all the eastern half of the United States, generally has ample annual precipitation, an asset which has helped build a rich and diversified economy but intensified the problems of floods, soil drainage, loss of soil, and loss of fertility. Precipitation in general increases from west to east and from north to south in the region, with a range from about 28 inches to 47 inches. Precipitation is heavier in the summer months in the north, and more evenly distributed throughout the year in the south. Winter snows are common.

Streams drain principally to the big rivers — the Mississippi and the Ohio. Western Iowa drains to the Missouri River, and the extreme northern portions of Ohio and Indiana drain to the St. Lawrence River by way of the Great Lakes. Rivers are numerous; each of the states has important waterways that provide water for domestic and industrial use, navigation, recreation, and wildlife habitat. Among the well-known rivers are the Des Moines, Iowa, Illinois, Wabash, Miami, Scioto, and Muskingum.

The major water problems of the region are those associated with droughts, overpumping, floods, drainage, and pollution.

Although precipitation is usually reliable, droughts sometimes occur. In recent times, extended dry periods have occurred in 1948, 1952, and 1953. Drought in Illinois led to a statewide water survey in 1954, over 40 communities in the central and southern parts of the state having water shortages. Droughts not only deplete underground water supplies, but reduce streamflows, and aggravate pollution troubles by increasing load concentrations in low-level streams. During abnormally dry periods, forest insect populations increase and vegetation loses vigor.

Levels of underground water are falling at numerous points in the region, due largely to excessive pumping demands. Groundwater aquifers (water-bearing rock materials) are subject to heavy pumping in Ohio, particularly in the vicinity of Cincinnati, Dayton,

Canton-Massillon, Akron, Chillicothe, and Columbus. Other heavy pumping areas include East St. Louis – Alton, Chicago – Joliet, and Peoria in Illinois; Indianapolis and South Bend in Indiana; and Des Moines and Sioux City in Iowa.

The effects of floods are far-reaching. Besides the more obvious losses to life and property, floods disrupt industrial production, transportation, and communication; they interrupt the flow of trade and consumer goods; destroy agricultural crops; reduce land values; and pollute wells and other water supplies. Flood damage in the central region averages the heaviest in the United States, due to a combination of wide fluctuations in river levels and intensive development of flood plains. The Mississippi, Ohio, and Missouri Rivers and many of their tributaries are notorious for floods. Bad floods occurred in 1947 and 1952. The Ohio River, chief contributor to high water on the lower Mississippi, suffered its most destructive flood so far in 1937. Nearly all streams in the region flood occasionally, some of them regularly. Forests, as we shall discuss later, can help, in some circumstances very much, to reduce the high peak flows which produce disastrous results.

Wetlands are drained to lower the water table,[1] usually for the purpose of raising farm crops. The most extensive areas of drainage projects in the United States lie in northwestern Ohio, northern Indiana, and north-central Iowa. Within our 4 states possibly 21 million acres have been drained and planted to crops. Many enterprises, however, have been allowed to deteriorate through failure to maintain ditches and control structures.

The soil should be tested before deciding whether to drain, otherwise results may prove disappointing when crops are raised. Land in marsh or potholes, or subject to periodic overflow may be serving its most useful purposes when it is in commercial timber, or growing low vegetation which can be used by wildlife, while storing water at the same time. Cultivated crops are certainly not the "wisest use" for every type of land.

Pollution is one of the most serious problems facing this region and one of the most difficult in which to show progress since new sources of contamination continually appear. Industrialization and heavy population pressure have resulted in severe demands upon waterways for transmitting wastes. Sewage, industrial wastes, and sometimes acids from mine drainage are the principal toxic materials. Another and increasing form of pollution results

[1] The level in the soil at which free water occurs.

from the use and reuse of river water since this raises its temperature, frequently to the point where the water is unusable downstream for cooling or other industrial purposes. Heavily-polluted water is a menace to health and renders streams and lakes unfit for swimming, boating, and game-fishing. Acceptance of a situation in which rivers are used as sewers reflects an indifference in the public mind that cannot be entirely excused by blaming the industries responsible.

The Water Cycle

The functioning of a forested watershed[1] can be explained by following the path of water after it reaches the tree crowns.

Some of the water falling as precipitation is intercepted by vegetation and part of it returned to the atmosphere in evaporation. The amount reaching the ground is determined by the species and density of vegetation and its litter; season of year; and amount, intensity, kind, and distribution of precipitation. Once it reaches the ground, water may follow one of several different paths. Some may evaporate from the surface; some may directly infiltrate[2] the soil; some may run across the surface and in so doing either evaporate, infiltrate the soil, or enter a stream.

Of water that penetrates the soil and percolates[3] through it, some may be taken up by plant roots, later to be transpired;[4] some may move laterally through the soil; and some may travel slowly downward to underground basins of sand and gravel, or to reservoirs of porous rock. Some of the water in underground basins may move laterally toward the surface at lower elevations and there become subject to evaporation or transpiration, form springs or lakes, or flow into streams.

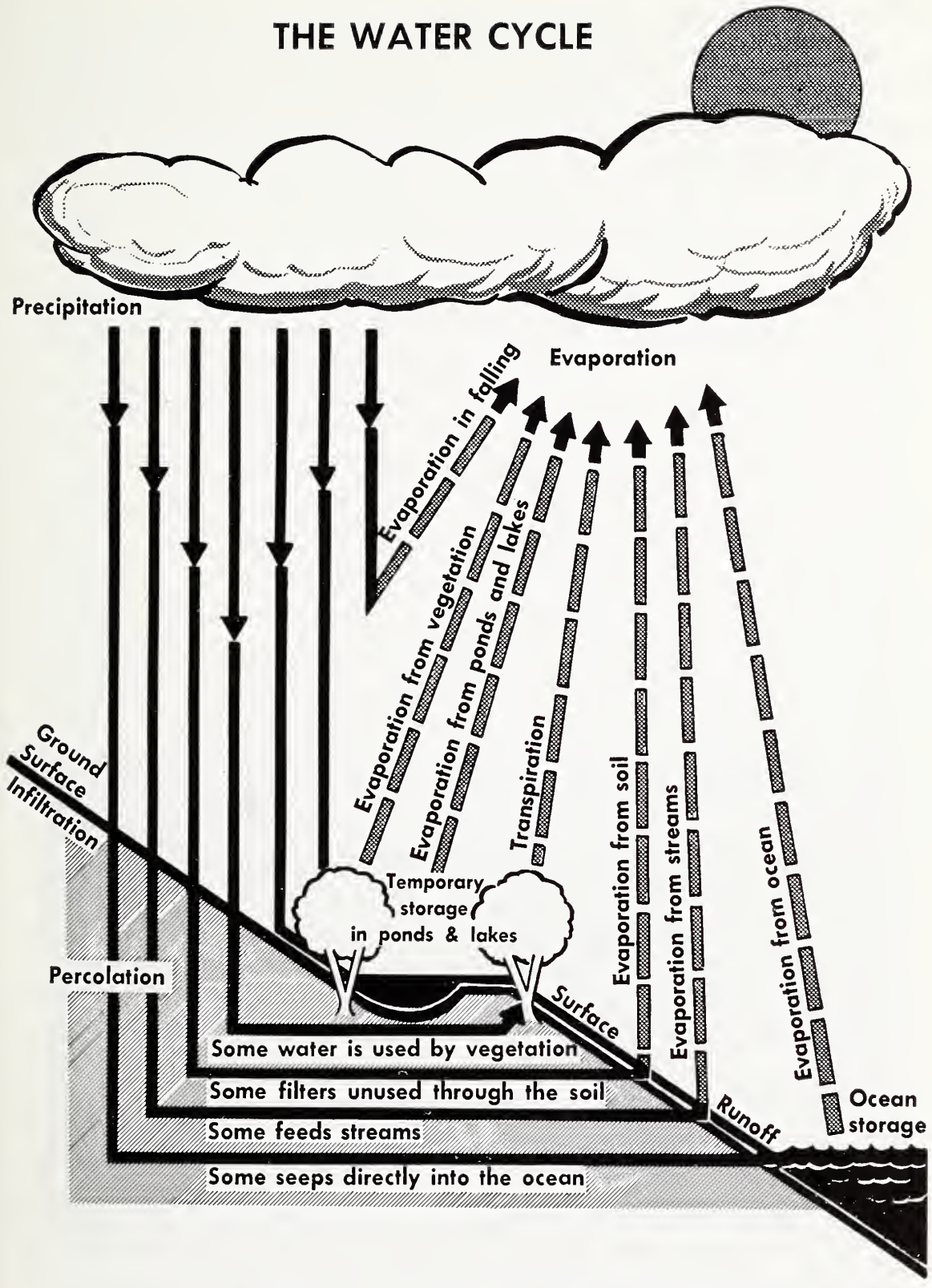
Of the water in streams, some may flow into ponds or lakes; some may be lost by evaporation or be transpired by streambank vegetation; and some may percolate downward to underground basins. Some of the water that enters a stream will eventually

[1] Watershed: the area from which a stream gets its water. It may be as small as part of a farm, or as large as several states.

[2] Soil with innumerable openings of many sizes to which water clings, is more like a filter than a sponge, although the latter term is frequently used. Infiltration refers to the entrance of water into the soil at the surface.

[3] Percolation: the movement of water through soil.

[4] Transpiration: the loss of water vapor from a plant, chiefly through the leaves.



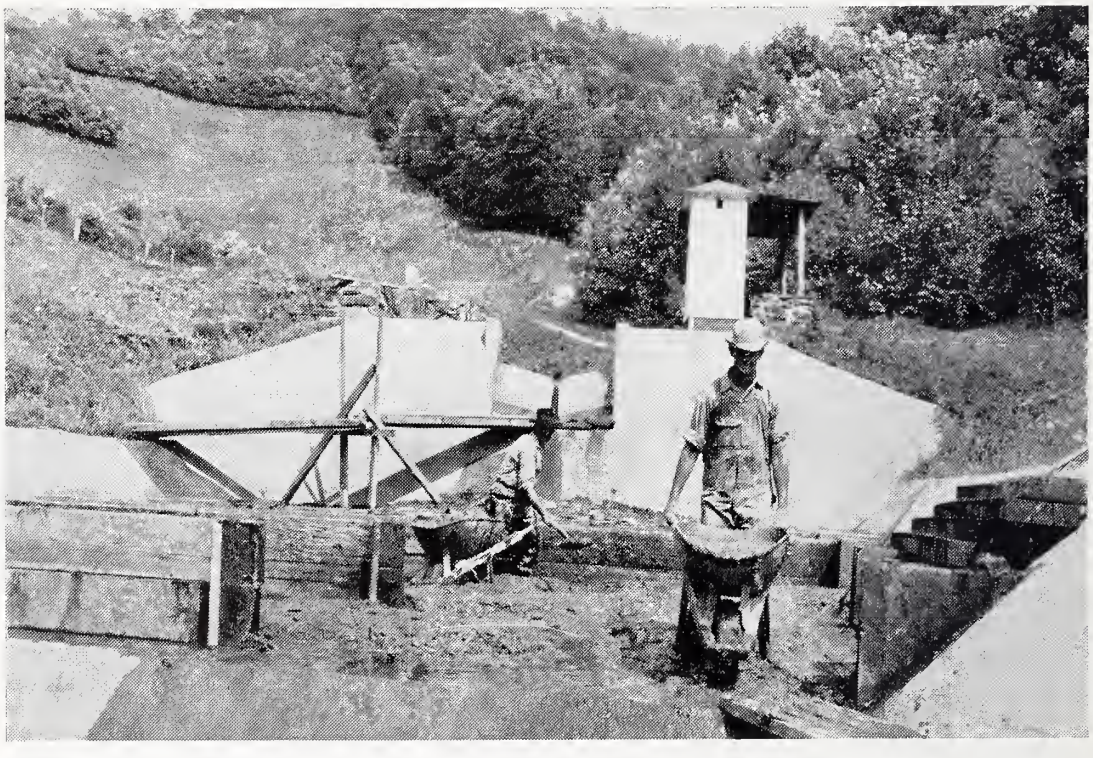
reach the ocean. When water evaporated or transpired from land surfaces or evaporated from lakes and oceans returns to the atmosphere, the water (hydrologic) cycle is complete.

If a watershed is forested, the forest is directly involved at all points in the cycle except in underground basins and in evaporation from oceans. In all other phases — interception, runoff, infiltration, percolation, transpiration, runoff, evaporation from soil

and inland waters, and accumulation in lakes or streams — the forest is a direct agent affecting the disposal of water. Substitute any other type of vegetation, or the absence of vegetation, for forests, and the same processes are affected, but usually to a quite different degree.

Erosion and Sedimentation

The impact of raindrops on bared soil dislodges and breaks up soil particles and splashes them into the air, moving perhaps 100 tons per acre during a storm. The soil's structure is broken down by the splashing process. Fine particles separate out, filling the tiny pores of the upper layer of soil, and sealing the surface. Unable to penetrate the soil, water runs off, collecting fine material at first and carrying it as suspended sediment. Wherever the velocity of the water slackens sufficiently, gravity causes the sediment to be dropped, except for the finest particles which remain in suspension for long periods. A sediment-load increases the scouring power of running water as it cuts gullies and wears away streambanks, and adds unwanted volume in floodtime. Sediment is frequently deposited upon croplands, pastures, or upon fish-spawning beds. It may smother water plants and destroy bottom-living insects and other forms of fish food.



This is an experimental area. The men are removing sediment from a catchment basin at the base of slope that had been heavily pastured and cultivated. During 65 minutes of flow in one storm, 152,000 pounds of soil and rocks came off this 23-acre mountain farm.

Soil may be removed in thin layers from an exposed surface by water or wind (sheet erosion). Tiny channels or rills may be formed by moving water, and deepen into gullies (gully erosion). Topsoil losses represent a reduction in organic matter and soil depth. Gullies serve as drains for subsurface water also, lowering the water table in the vicinity.

Any reservoir will fill with sediment in time. But whether the life expectancy is 16,000 years, as in the case of a certain reservoir in the Rockies with a well-managed forested watershed, or less than 50 years, an average estimated life for ⅕ of the nation's municipal water-supply reservoirs, depends to a large extent upon the use to which the watershed is put. Studies of Ohio farm ponds, for example, show that sedimentation is negligible when the watershed is entirely in grass or woods. When the watershed is 25 percent in corn, 25 percent in wheat, and only 50 percent in grass, however, a small pond may lose more than ⅕ in capacity in 10 years, equivalent to reduction in depth from 7 feet to about 5½ feet — perhaps a critical difference in time of drought. Accumulated sediment may be hauled out of ponds, but usually only at considerable expense.

In cases where erosion is severe, a combination of checkdams and tree-planting may be used. The checkdams here were built of logs. These checked the velocity of the water in the gully. The banks were planted with black locust to stabilize the soil. The young trees are 3½ years old. Grass is starting to heal the gully. Eventually the logs will rot and disappear. Hoosier National Forest.

An example of siltation resulting from erosion is Lake Decatur, Illinois, an artificial reservoir constructed in 1922 to supply the city of Decatur with water. Today the lake is about ⅓ filled with silt, 90 percent of which originated on upstream farms and was deposited by the Sangamon River.

Infiltration and Percolation

Water from rain or snowmelt will enter soil if the soil is porous and not already saturated. Litter on the surface prevents dislodgement of soil by raindrop splash, and serves to slow the movement of water, increasing its opportunity to penetrate the soil. Immediately below the litter, organic matter is at its highest concentration and the soil has large pores, or voids, between soil particles. Below this humus layer the pores usually become smaller as the soil becomes more mineral in nature. (If the lower mineral layer is sandy it will have relatively larger pores and a higher proportion of them than if it is clayey.)

The dryness of soil, as well as its composition and texture, affects the rate at which water enters. If soil is dry, more water must be applied to "prime" it or make it wet than if it is already moist. The wetter a soil is, the less pore space is available to take up additional water.

Woodland soil is rich, mellow, and loose.

Once in the soil, water will percolate laterally and downward as long as the supply from above continues, and as long as pore space can be found. Small pores (e. g., less than 0.05 millimeter in diameter) are more effective than large pores in holding water (storing it) against the force of gravity, because of the characteristic of water molecules to cling to surfaces ("surface tension"). A given volume of soil composed mainly of small pores provides a greater internal surface area than if large pores prevailed. Such a soil therefore permits more water to be held against gravity. By contrast, the proportion of water that clings to the surfaces of large pores is relatively much less than the proportion which moves down and out of the soil.

Other things being equal, the deeper the soil, the greater its total water-holding capacity. Water movement is aided by living roots which serve as paths for percolation, the cavities of dead roots filled with porous material, and the channels created by burrowing mammals, rodents, worms, and insects.

The result of having large pores and small pores in soil is that some water is stored and some is merely delayed in movement (temporarily stored). The degree of wetness of a soil may therefore vary from the stage where water moves freely although slowly through the soil's pores, to mere films of moisture surrounding individual particles.

Water is removed from soil by the transpiration of plants, particularly by deep-rooted trees, and by evaporation from the surface soil layers. Some water may collect in deep storage out of reach of plant roots and below the surface zone that is subject to evaporation, and some may percolate downward and outward to reappear in a spring or a stream.

Where soilwater is available, transpiration in the forest may remove great quantities of water from the soil. An experiment conducted where the annual precipitation was 31.5 inches showed that in a beech forest 10.8 inches or 34 percent of the total precipitation was taken up from the soil and transpired by the trees, while in a Scotch pine forest 3.1 inches or 10 percent of the water that fell was removed by transpiration.

The removal by transpiration of water stored in the soil helps explain why a forest is effective in reducing flood stages and associated damage. Depleted by transpiration, the soil is in condition to receive surplus water which would run off if the ground were more nearly saturated. The water transpired, however, is not avail-

able for streamflow. From a water-yield standpoint, vegetative cover in excess of that needed for protection against surface runoff and erosion is surplus and results in an unwanted drain on soil moisture, particularly where water shortages are serious and frequent.

A soil-reservoir that emptied itself between storms would be particularly efficient in furnishing storage. Intensity and distribution of rain or snowmelt are therefore important factors influencing the rate of runoff. A watershed might be able to absorb hard rains if they came intermittently, or prolonged gentle rain, or slow snowmelt, whereas a long hard rain or rapid snowmelt continued through several days might result in a flood even under dense forest.

The protective cover of the woodland is evident here in the overhead canopy and in the undergrowth below.

Watershed Management

In the central region, the major land uses in order of acreage are: cropland, pasture, and woodland. In the southern end of Illinois, the southern fourth of Indiana, and the eastern and southern thirds of Ohio, the order of acreage becomes: woodland, cropland, pasture. The degree of management being applied on the ground would be rated highest for cropland, lower for pasture, and lowest for woodland.

No land in the Midwest is known to be managed primarily for the best yields or most efficient control of water. One of the nation's better-known water control projects, however, is in the central region. It is located on the watershed of the Muskingum River in eastern Ohio on some 5 million acres known as the Muskingum Watershed Conservancy District. Following the successful downstream flood-control efforts of the Miami Conservancy District of Ohio farther west on the Miami River, the Muskingum District was organized in 1927, obtained a federal-aid grant, and proceeded with a plan that involved construction of 11 reservoirs by the U. S. Corps of Engineers, on land purchased by the state of Ohio. Cooperation of government — federal, state, and local — with private landowners has resulted in highly successful reforestation of 32,000 acres around the reservoirs, and other positive measures on farmlands and District lands. Today the lakes and the surrounding areas provide hunting, fishing, swimming, boating, hiking, camping, and picnicking opportunities, as well as sites for cottages and organized-group camps. The importance of these recreation benefits is magnified because of proximity to large centers of population. Timber is cut and sold from District lands around the reservoirs under a plan of sound forest management. *Multiple-use*, the principle of "many uses" in the same general area, is a basic policy.

The publicly-owned forests, state and federal, in the central region are administered with water control as an important phase of multiple-use management. However, less than 10 percent of the forest land in each of the 4 states is publicly-owned. On 441,000 acres of national-forest land located in Ohio, Indiana, and Illinois, the U. S. Forest Service is charged by law to protect and improve watersheds as a primary responsibility.

Since water is a product which transcends political boundaries, the river basin is a logical unit for the planning and management of water use. Probably the nation's best example of the coordinated approach in action is seen in the Tennessee Valley, where a federal agency is responsible for integrating the development and use of a great river extending into several states. TVA has as a goal the axiom that the behavior of water downstream begins with control of "little rivers" upstream. TVA recognizes that the little rivers can only be controlled by managing the watershed above them — the source of their water. Of course this goal has not yet been fully achieved on any river basin in the United States.

This shows need for watershed management. There is evidence of flooding. The gravel bars are the result of erosion upstream.

Demonstration "pilot" programs in small-watershed protection and improvement are being initiated nationwide on a broad scale. Funds were first appropriated by Congress in 1953 to develop practices aimed at protecting and improving small, sample watersheds of various types. The U. S. Soil Conservation Service has primary responsibility for the program with the U. S. Forest Service in charge of the forestry phases. Projects in the central region are located as follows:

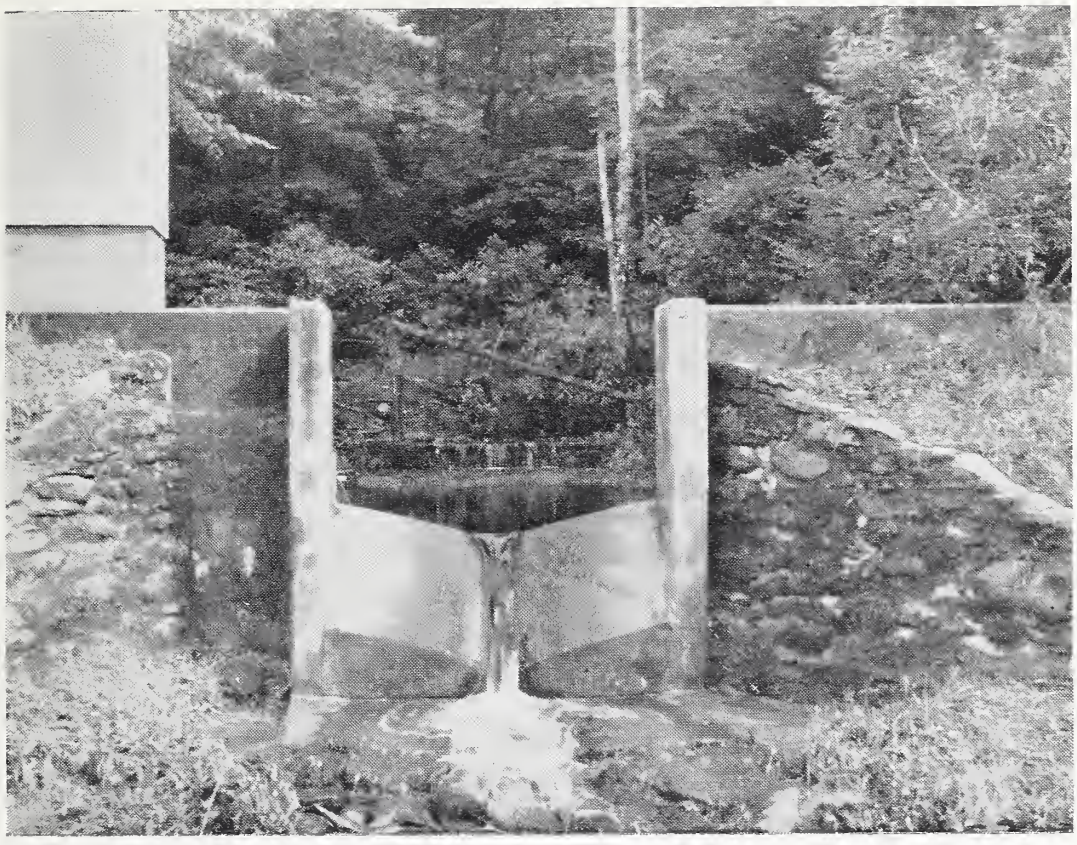
4 in Iowa — Honey Creek, Lucas County; Mule Creek, Mills County; Nassau Creek, Sioux County; and upper Plymouth Creek, Plymouth County.

3 in Illinois — Hadley Creek, Pike and Adams Counties; Money Creek, McLean County; and Old Tom Creek, Warren and Henderson Counties.

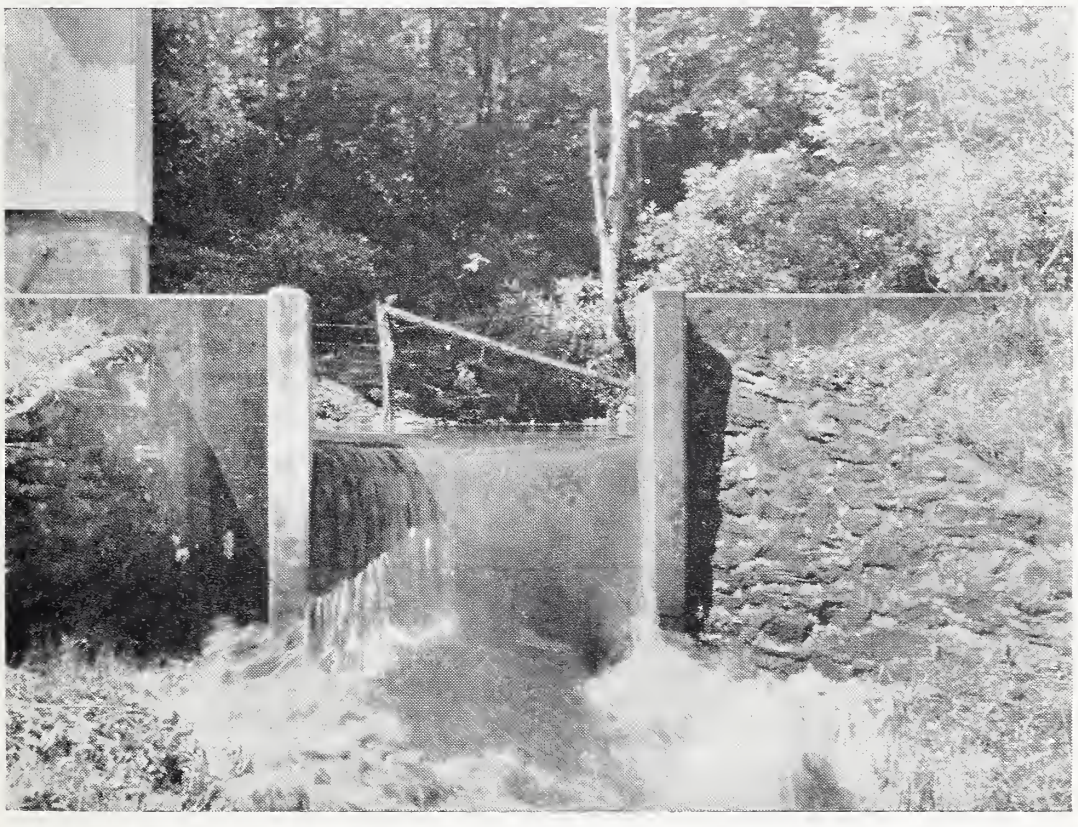
1 in Indiana — Flat Creek, Pike and Dubois Counties.

2 in Ohio — upper Hocking River and Hunter's Run, Fairfield County; and Clear Creek Branch of Rocky Ford River, Highland County.

Another law, passed by Congress in 1954, provides for federal assistance to states and other public bodies on watershed projects. Governors designate specific state agencies to examine and act upon applications. Technical responsibilities are centered in the Soil Conservation Service and Forest Service as in the demonstration projects mentioned above.



This is a weir for measuring waterflow at the base of a sloping experimental farm woodland. Before the woods were pastured, water from rainstorms infiltrated the soil, reappearing as clear, pure water. This was proved by 7 years of continuous records.



The same weir. The woodland was pastured for 6 years and continuous records of runoff were kept. This shows the result — excessive runoff during and immediately after storms.

Soil and vegetation are the raw materials of watershed management. By manipulating them, streamflow may be regulated and the quality of water changed.

The best possible vegetative cover should be maintained when quality of water and regulation of streamflow are paramount. Grass cover holds soil in place and prevents erosion, but its ability to develop storage capacity in the soil is low and it has limited value in retarding surface runoff. Undisturbed forest has proved to be the cover most effective for soil protection, flood control, and water storage because infiltration and percolation are relatively rapid. Shrub cover may be nearly as effective as forest. Row and field crops, which leave the soil bare part of the year (and in some instances part of the soil bare all year), are the least effective of all for these purposes.

Under management dedicated to watershed protection, all bare spots would be seeded or planted. Stocking of trees would be dense enough to protect the soil from impact of rain, to supply adequate litter, and to provide shade. Deep-rooted species would be preferable in the central region, especially on steep slopes subject to slides. The type of cover and species maintained on each part of the watershed would depend upon its physical characteristics, the major function of the watershed, and the supplemental benefits desired, such as wildlife food and cover, recreation use, sales of timber, etc. Man's activities should in no way impair the formation of litter and humus, or the maintenance of a porous soil. Protection from fire and overgrazing would be an essential requirement.

Usually it is necessary to modify existing and customary land-use practices when a watershed-management program is set up. Farming methods might have to be improved, landclearing operations halted, eroding roadways relocated or revegetated, and livestock grazing replanned, reduced, or eliminated. Good land use is good watershed use, and readjustment in farming practice to provide better water control, such as changing from cultivated crops to pasture or woodland, would in most cases prove to be financially profitable.

It should not be assumed that the water-storage capacity of a well-managed forest is without limit. Prolonged rain or rapid snowmelt may result in excess runoff, especially in the spring. Some of the nation's worst floods have occurred in the central region and may be attributed to a simultaneous combination of

melting snow and heavy rain, when frozen ground on cultivated and pastured fields and in grazed woodlands, has compounded the effects. Dams, levees, and other engineering works offer a partial solution to such surpluses. The forest may be of great benefit, however, since it has been determined that impervious frozen soil is much less likely to form under a good hardwood forest that is ungrazed than in cultivated or pastured land, grazed woodlands, or coniferous forests.

Even when the storage capacity is exceeded, well-protected forest soils extend the period during which floodwaters rise, and reduce the height of crests that are reached. Local "flash" floods that result from sudden downpours may be prevented in watersheds having good forest cover.

Forests are intimately related to water supplies. They help insure that water coming from a watershed will be of high quality. Forests help maintain even flows in streams, reducing flood peaks and increasing low flows. Forests make streams and lakes more attractive and more useful for recreation purposes. The most effective watersheds have stable soil with a high capacity for infiltration and storage. The art of watershed management is not so much a matter of managing water directly as of managing the forests and other vegetation that condition the soil, thereby controlling water from the moment it reaches the ground.

4

WOODLAND COMMUNITIES

Growth and Survival

To understand forestry one must see the forest as well as the trees. To some people, a tree is a tree and when enough trees are found together you have a forest. A forest, however, is much more. It is a community, and it exerts certain influences as a unit that one tree or a group of trees cannot possibly exert.

A tree growing alone in the open looks much different from a tree of the same species growing with many others in a woodland, and it actually is much different. You can hold a picnic under a tree growing in the open; it will furnish wood for fuel if it is cut; there may be shrubs and grass growing under it that provide food and cover for wildlife; and of course a tree makes the landscape more attractive. But the "sphere of influence" of a lone tree is small. The soil beneath it will not be woodland soil; it will not absorb and filter water the way woodland soil will. One tree will not be very effective in helping prevent floods, and it will produce little valuable lumber because it has had no neighbors to provide the shade necessary for a tall, clean stem.

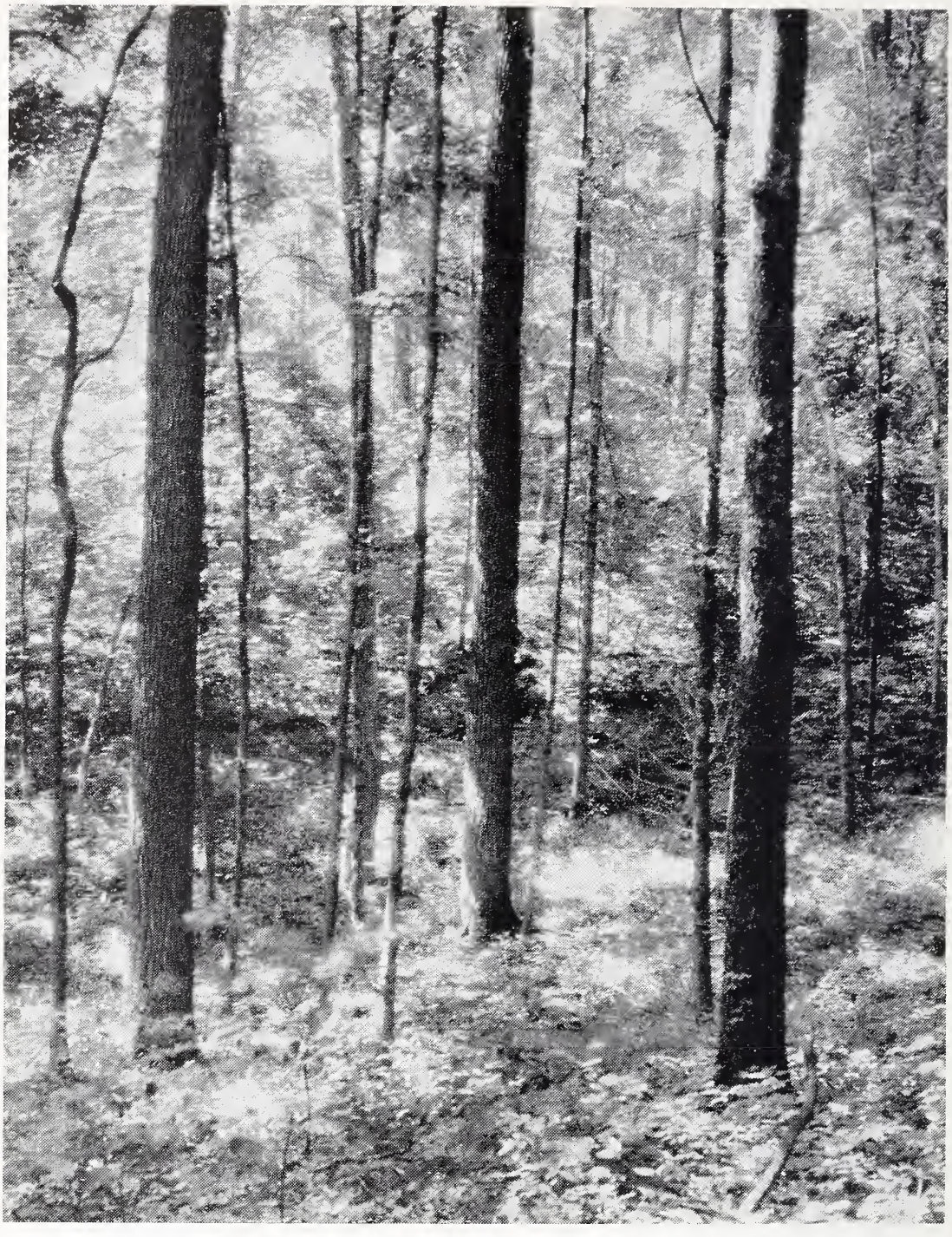
If they are in a group, trees will be competing with each other for sunlight and moisture. *Competition* is a most important factor in the development of timber stands. The trees which will successfully withstand group competition for sunlight will be those able to expose their leaves to adequate sunlight. Another big advantage will be with those best able to reach the available supplies of moisture and mineral nutrients with their roots. If the soil is moist, or if there is plenty of precipitation, competition for water will not be as critical as competition for sunlight. But if the supply of moisture is small and sunlight is abundant, as on a dry ridge, the trees will be in competition chiefly for moisture. If a group of trees is composed of species that prefer shade, those individuals that can best withstand the densest shade will survive the competition.

Nature is lavish in scattering seed or in producing sprouts. But of many thousands of tree seeds or sprouts that begin life upon an acre of land, only a few thousand will be successful, and of these, not more than 50 may actually reach maturity.

At the time a tree seed falls to the ground, a struggle for growth and survival begins. It may be eaten by squirrels or birds, crushed by the hoof of a deer or cow. The seed may be killed by a forest fire, by too much water or not enough, by frost or heat; or it may fall upon a rock, be successful in starting growth, and then die for lack of food.

"Nature is lavish in scattering seed . . ." Silver maple seedlings on bottomland subject to seasonal flooding.

By the time a seedling reaches a height of several inches it may find itself in a spot too dry or too hot or too shady, or too barren or too wet. It may be trampled and broken by an animal. As it grows older it may have its buds and new shoots eaten off by cattle or other animals. Most of the seedlings that begin life in a forest will die. If a seedling succeeds in growing into a sapling with a diameter of several inches, it may be cut to make a fence post, it may be bent or cracked by the wind, or it may have its branches broken by snow or sleet permitting disease to enter the wound. In competition with other saplings for sunlight, moisture, and food some will be overtopped *(suppressed)* and die. Others will carry on the struggle for the living space thus gained.



The forest — a dynamic community. All its components, living and dead, plant and animal, continually exert an influence upon each other. There has been no cutting in this stand.

The loss of some young trees by suppression often is beneficial to the forest since it permits the remaining trees to accelerate their growth rate. Men may thin out dense stands of saplings by cutting or girdling some of the trees, accomplishing the same purpose.

As the sapling grows into a pole, enemies, dangers, and risks are still present. It may be killed by fire, insects, or disease at any stage of growth. It may be suppressed by neighbors, or injured by sleet or wind, lose vigor, and finally die. Here, too, the loss of

individual trees will serve a useful purpose, for trees demand more of the available supply of light and moisture as they approach maturity.

By the time a tree is mature it may have developed a tall, straight stem with a full, rounded crown; it may then be selected for harvest, or left standing as a source of seed. If in a reserved area, it may live unmolested to old age. Disease may have entered by way of a fire scar, with fungus growth riddling the wood. Or insect larvae may have burrowed in the inner bark, girdling the tree and causing it to die. Perhaps the mature tree has outrun its neighbors, developing a spreading "wolf tree" form, or has been suppressed to a stunted form from which it did not recover; in either case, killing it is warranted.[1]

If a tree survives all hazards, it may continue living for many years. Its growth will slow down and may practically cease. It may reach old age — perhaps 300 years, if it is a white oak. It may stand until wind or snow or a falling neighbor topples it to the ground, there to fall apart and slowly decay as litter on the forest floor. Its usefulness does not end, however, for it will provide organic matter to enrich the topsoil with chemical elements stored in its wood through the years, supplying a new seed, a new plant — perhaps a tree — with some of the substances needed for a new life.

What Kind of Woodlands?

Forests comprise the natural vegetation over a large part of the earth. They are found wherever there are seed sources and suitable conditions of climate and soil for survival. Different factors determine where a forest will be found and what kind it will be. Every forest, every stand, has an individuality which is the result of the interacting forces of heredity and environment.

Inherited factors

Trees inherit certain characteristics the same as animals do. A white oak seedling develops into a white oak tree no matter to what location it may be transplanted, and it will always produce other white oaks as offspring. Inherited characteristics are responsible for the common resemblance in all white oaks and also for the differences in individual white oaks.

[1] Wolf tree: one with wide-spreading crown and large branches; produces little timber of commercial value, and occupies more space in the woods than it is worth.

Resistance to insect or disease attack is a characteristic that may be inherited. Species like willow, silver maple, and pin oak have inherited an ability to grow well on wet soils, while redcedar, honeylocust, and persimmon do well on dry soils. Most species have inherited an ability to grow in a moderately wide range of moisture conditions; chinkapin oak, American elm, sassafras, and hackberry are especially adaptable. Rate of growth to some extent appears to be an inherited characteristic also. For example, species that grow rapidly in favorable locations are eastern cottonwood, boxelder, white ash, yellow-poplar, black locust, and sycamore. However, most oaks, sugar maple, beech, and redcedar grow slowly. Age of reaching maturity also appears to be inherited within the species: butternut, boxelder, and black willow are short-lived, while white oak, beech, and sycamore are long-lived.

Certain species have inherited the ability to withstand more shade than others. This ability is expressed as degree of *tolerance* of shade. *The concept of tolerance is one of the most important in basic forestry.* A species may be more tolerant on some exposures[1] than others and in certain parts of its range;[2] and it may exhibit more tolerance as a young tree than when it is older, or vice versa.

Some of the species classed as *tolerant* ("shade-loving") are American basswood, American beech, sugar maple, and black tupelo. Species of *intermediate tolerance* are numerous and include the ashes, white oak, northern red oak, black walnut, American elm, redcedar, scarlet oak, shagbark and mockernut hickories, white pine, and sweetgum. *Intolerant* ("sunlight-loving") species include shortleaf pine, black locust, eastern cottonwood, yellow-poplar, American sycamore, silver maple, and red pine.

Species which can best withstand open sunlight and extremes of climatic conditions when young will have the advantage over other species in becoming established on bared soil or on ground where the plant cover is sparse. But unless these trees are of species that progressively develop increased tolerance as they grow older, and grow fast enough to keep ahead, they will become dominated by tolerant species able to survive the ever-deepening shade. It is not difficult to see why the climax, or final, stable stage of a forest is composed of tolerant species, while the first invaders of abandoned fields and their immediate successors are intolerant.

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[1] Exposure: the direction in which a slope faces.

[2] Range: area within which a species, plant or animal, occurs naturally.

Leaves of sugar maple exposed to sunlight. Note horizontal arrangement of leaves. This species is able to survive in shade.

Site factors

The place where a plant grows is its location, or *site.* In forestry, site has a connotation of quality of location as applied to the ability to grow certain species of trees, and how fast. In addition to inherited factors just discussed, factors of environment or location or site also affect the character of the forest. These exist outside the tree itself and are called *site factors.*

Different species show preferences for different kinds of sites. A moist site may be favorable for sycamore or pin oak but unfavorable for scarlet oak or black locust. A site may be cool and shaded — first quality for basswood or sugar maple — but second quality for shortleaf pine or mockernut hickory.

Since any species will grow faster in height on a good site ("good" for that species) than on a poor site, the height of a tree at any given age is an indicator of the quality of the site. Height is therefore commonly used as a *site index.*

The more important site factors are closely related to soil, exposure, and moisture. In the southern part of the central region, topographic position — in a cove, on the slope, or on the ridge — is one of the important site factors. The influence of "position,"

however, results from a combination of the more basic factors of soil, exposure, and moisture.

1. Soil depth and structure.

Most species do best on deep, mellow soils of the light, sandy-loam or silt-loam type. Examples are the ashes, black cherry, slippery elm, and northern red oak. Cucumbertree and flowering dogwood seem to require deep, crumbly soils. Gravelly or rocky soils present rigorous sites for most species, but butternut, rock elm, and chinkapin oak will grow in such situations. Eroded, shallow soils are also difficult sites, but persimmon and sassafras do well on them. The ability of a species to survive difficult conditions of course does not mean that it would fail to grow more rapidly on better sites.

Few species show a preference for the heavier, clayey soils that retain water, but some will develop well on such sites, including sugar maple and several oaks — post, blackjack, overcup, bur, swamp chestnut, and swamp white oak. Post oak and blackjack oak have the ability to thrive on soil underlaid by clay pavement or "hardpan." A number of species have developed an adaptability to soils of considerable variety and structure; examples are eastern cottonwood, American beech, American elm, honeylocust, red maple, and most of the hickories.

Shortleaf pine and yellow-poplar (YP) were planted together 7 years before this photograph was taken. Topsoil is thin, subsoil compact. Site is unfavorable to yellow-poplar and little of it will survive to the final stand. Shortleaf pine is doing well.

Shortleaf pine (SP) and black locust (BL) were planted together 7 years before this photograph was taken. Subsoil is loose and mellow. Site is favorable to both species. Although the locust is outgrowing the pine in this early stage, the pine will ultimately overtop it and dominate the stand.

2. Exposure.

The sun is never directly overhead in the latitudes of the central states but is always south of the zenith. Exposure therefore has a bearing on the amount and intensity of light and heat received upon the land.

Exposure has an effect somewhat comparable to that of season of the year. Other factors being equal, southwest slopes, and to a lesser extent west and south slopes, are warmer and drier, while northeast slopes, and to a lesser extent east and north slopes, are cooler and more moist. Species that show preference for warm sites include black locust, shortleaf pine, Virginia pine, redcedar, and blue ash. Cool sites are preferred by sugar maple, hemlock, white pine, basswood, yellow-poplar, beech, white ash, and flowering dogwood.

3. Amount of moisture in the soil.

The amount of soil moisture available for plants is governed by the amount, intensity, and distribution of precipitation; surface drainage; relative amounts of organic matter, sand, and clay in the soil; depth to water table; presence and proximity of tight subsoil; rate of evaporation, etc.

Species that do best on moist or wet sites include black ash,

silver maple, red maple, river birch, sweetgum, cottonwood, bald-cypress, willow, slippery elm, sycamore, pin oak, swamp white oak, and alder. Some species will thrive on the drier soils, among them being the red, shortleaf, and Virginia pines, rock elm, persimmon, and the chestnut, chinkapin, and scarlet oaks. Most species prefer a moist but well-drained soil neither excessively dry nor wet.

4. Soil acidity.

Most soils of the central region are mildly acid. There is no evidence, however, that the chemical reaction of a soil (its degree of acidity or alkalinity) in itself determines the presence or absence of a species on a site. Some species, nevertheless, develop quite well on acidic or alkaline soils while others do poorly. In general, conifers will tolerate more acid soils than the hardwood species.

The influence of chemical composition of soil is well illustrated by experiments in planting the spoil banks of raw earth and rock left in stripping for coal. This subject is discussed more fully on pages 94 and 95.

A good site for yellow-poplar. Three trees of sawtimber size were cut, leaving this opening. (Old stump visible at "S"). The photograph was taken 6 years after the cutting. Yellow-poplar, an intolerant species, has filled the opening with a dense stand of saplings. Such openings must be created in the central woodlands if reproduction of desirable species is to be obtained.

Natural Succession

Site is the composite condition resulting from all the factors that have an effect upon an area; for example, soil, topography, and the presence of organisms of all kinds including man. It follows that vegetation is an expression of site conditions; its composition as to species, its density, its rate of growth, etc., are all conditioned by the site.

Nearly everyone has observed how plants of some kind invade areas of raw soil. A newly-cut roadbank or an abandoned garden plot quickly becomes covered with vegetation in this region; however, in areas of poor soil and sparse rainfall the invasion may be extremely slow, or fail to take place at all.

If an area large enough to show natural changes, such as an abandoned field, is left undisturbed, a phenomenon of sorts will occur. Different types of vegetation will gradually follow or "succeed" one another through the years until a point is reached where the type will remain comparatively stable. Plant development will have attained the highest stage of which it is capable for the existing climate and site; vegetation will be completely in equilibrium with environment. This final stage is known as the climax stage and the vegetation present is of the *climax type.* (For names of climax forest types in the central states, see page 85.)

The slow progression of plant communities toward the climax stage is known as *succession.* The process is influenced by long-time climatic changes. Progression is orderly, but may be interrupted by fires, insect or disease epidemics, storms, floods, and droughts. Timber cutting, grazing, draining, and damming all affect succession, and may produce severe dislocations. When a forest is destroyed, several hundred years may be required before the climax type becomes established. Beginning with bare ground, upland[1] forest succession in this region takes the following course:

annual grasses and weeds
perennial grasses and weeds
shrubs (sometimes omitted)
intolerant trees, and ending with
tolerant trees (i. e., relatively tolerant for that particular climatic and soil climax)

When man plants trees on open ground he eliminates the lower stages and "shortcuts" the succession process.

[1] Uplands: elevated ground as distinguished from lowlands which are usually on or near rivers.

Shortleaf pines invading an abandoned field. The field was an oak and hickory woodland before it was cleared.

Climatic or soil factors, or fire, may result in a subclimax stage of succession continuing in an arrested condition for hundreds or thousands of years. For all practical purposes this static condition becomes the climax stage. To serve his needs, man may actively maintain a succession stage of his choosing anywhere below the climax. Timber of the subclimax, for example, may be more valuable, or more desirable than the climax type.

Lakes and ponds show succession stages as well as the uplands. All are in the process of being filled with sediment carried in from streams and with organic debris from the living things growing in and near them. A young, deep lake shows changes slowly, but once the bottom fills to the point where the lake is shallow, changes are more noticeably rapid. Vegetation pushes out from shore, the lake becomes a pond, and as more and more vegetation accumulates, the filling process accelerates, eventually forming a wet meadow.

Aquatic vegetation usually develops in one of two directions when the wet-meadow stage is reached: (1) toward a climax prairie of grassland; or (2) toward a forest community of wetland species, followed by upland intolerant species, and ending with a forest of tolerant species.

Examples of climax vegetation, either prairie or forest, are rare in the central region. A few protected groves preserved from man-

made disturbances, a few grass communities along railroad right-of-ways or in fenced cemeteries, are about all that remain. Elsewhere in the nation, both east and west, climax forest types exist in large segments, but primitive grassland has almost disappeared everywhere.

Every woodland has an individuality because species compositions vary; sizes, ages, number of stems per acre, and topography vary also. Each woodland is different. A woodland may be open and sunny, or dense and dark; it may follow a river or crown a high ridge; it may consist of conifers, or hardwoods, or both. Forest types also have individuality. A person totally unfamiliar with forestry can sense a difference between pine forest, thickets of young oak, bottomland swamp timber, and open farm woods of oak and hickory. Smaller divisions of the forest — woodland communities — have a "personality" too: the willow and red maple of the stream border; clusters of redbud and dogwood blossoming brightly in bare woods; the plantation of pine and locust on the hillside; the family of hickories on the ridge above the pasture. And in each community of trees the individual has character — the oak with leaves that cling in winter, brown against the white snow; the sassafras flaming into color in October; the yellow-poplar standing straight and tall in the deep woods; the sentinel pine beside the huddled scrub oaks.

A woodland is a community of trees, shrubs, herbaceous plants, mosses, lichens, microscopic plants and animals, birds, mammals, insects, earthworms, and other life forms. These act upon others of their kind, act upon other living things and non-living substance, and in turn are acted upon. A woodland is a complex biological mechanism, and a change in status of any part may change the balance within the entire community. Conservation practice must therefore be based upon an understanding of this community relationship.

5

WILDLIFE HABITAT

Effect of Environment

The wild creatures of the woods provide fun, furs, and food. They add interest to the outdoors. In woodlands and their waters a variety of wildlife obtains food and cover — song birds, upland game birds, waterfowl, game mammals, fur bearers, predators,[1] other mammals, reptiles, animals of the soil, fish, and other aquatic animals.

All forms of wildlife require food, water, and cover protection. Land will not support wildlife unless all 3 requirements are met. Just as different species of plants require different sites, so do different species of animals require different habitats.[2] The weasel family provides a good example of closely-related animals that require different kinds of habitat. The otter lives much of the time in water, the mink in marshes or on shorelines, the weasel in uplands on the ground, and the marten in uplands in trees. Most animals move about in a more or less restricted central area which is their home range.

Wild animals can successfully breed, rear young, obtain food and water, and find cover only where a suitable range of conditions exists. Deviations in habitat will therefore include, or exclude, certain forms of animal life; and as the habitat changes, so will the animal life that is dependent upon it, either by increasing in numbers, by decreasing, or by disappearing altogether.

Despite its obvious importance, only recently has public attention been focused on habitat as a factor affecting the presence and abundance of wildlife species. Even today, in questions involving game management, many persons think in terms of animals alone, not understanding that animals are only one part of a larger biological mechanism that includes their habitat.

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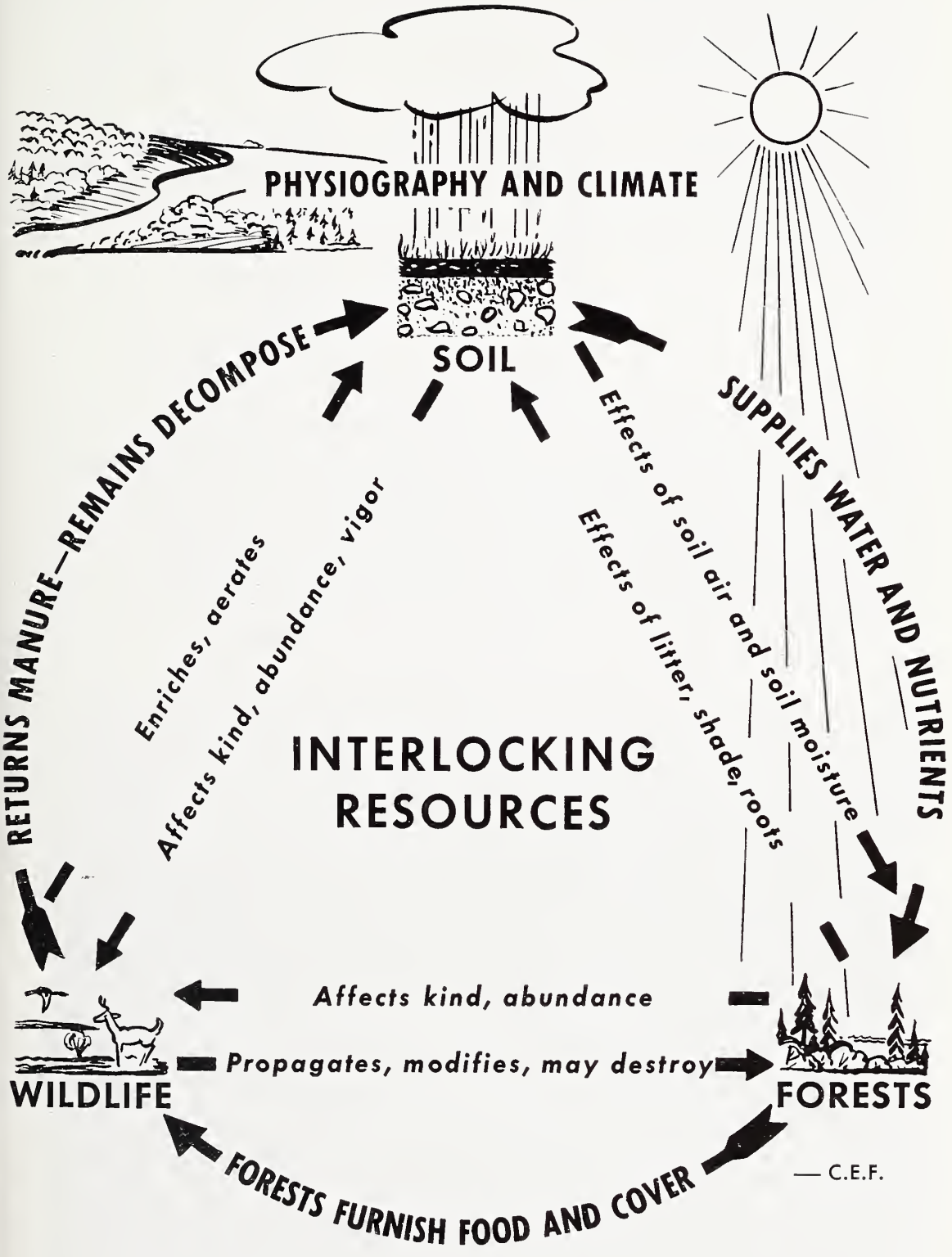
[1] Predator: an animal that preys upon other animals to obtain food.

[2] Habitat: environment in which the life needs of a plant or animal are supplied.


PHYSIOGRAPHY AND CLIMATE
SOIL
RETURNS MANURE—REMAINS DECOMPOSE
Enriches, aerates
Affects kind, abundance, vigor
Effects of soil air and soil moisture
Effects of litter, shade, roots
SUPPLIES WATER AND NUTRIENTS
INTERLOCKING RESOURCES
Affects kind, abundance
Propagates, modifies, may destroy
WILDLIFE
FORESTS
FORESTS FURNISH FOOD AND COVER
— C.E.F.

Having rather uniform climate and elevation, the various types of habitat in the central region may be classified rather simply on the basis of cover. The 3 principal types are (1) water and wetland, (2) woodland, and (3) open country of brush, grass, and scattered trees. Following are the more important mammals and game species in each type:

WATER AND WETLAND	WOODLAND	OPEN COUNTRY
Fish	White-tailed deer	Bobwhite quail
Ducks, geese, other waterfowl	Ruffed grouse	Ring-necked pheasant
Mink	Raccoon	Rabbit (cottontail, jack)
Muskrat	Bobcat	Skunk (striped, spotted)
Birds of shore and marsh	Squirrel (gray, fox)	Woodcock
Beaver	Coyote	Mourning dove
	Weasel	Woodchuck
	Wild turkey	Badger
	Fox (gray, red)	Prairie chicken
	Opossum	Ground squirrel

Such species as coyote, opossum, weasel, and skunk are usually found in both wooded and open lands, and songbirds of course are found in a variety of habitats. Within the range of each wildlife species, whether it includes one or more cover types, all the requirements of the particular species must be met or it will not thrive.

Transition zone between prairie and woodland, Iowa. Sharp ridges (R) are not wooded; north slopes (N) are completely wooded, south slopes (S) only partially.

Our animals are principally those of the farm and farm-woodland community and they have a relatively high tolerance to human activity. Black bear and wild turkey, driven out of the central region, have not returned as there is little congenial habitat of the denser, more inaccessible type of forest which they prefer. (For successful propagation of wild turkeys, some game specialists have recommended a block of at least 3,000 acres of wild, roadless land.)

Any wildlife species tends to increase in numbers to a peak. Then the pressure upon available food supplies becomes evident; natural enemies such as predators, parasites, and disease also reach a peak, and the wildlife begins to decline. Each wildlife species exhibits a characteristic population curve as to rate and extent of fluctuations. Predators are normally most abundant at the time their chief source of food is abundant and rare when their food animals are scarce. In pristine conditions undisturbed by man, as the population of cottontail rabbits increases, the population of its predators — coyote, fox, and bobcat — will increase. The chief limiting factors of a non-predator such as the rabbit are its cover and food supply — in other words, its habitat. When food supplies become scarce, rabbits are reduced in numbers, either from starvation or from the resulting weakness which makes them early victims of predation or disease. If cover is deficient, rabbits will be more vulnerable to predators.

Some lakeshores and marshes of the central region are favorable habitat for egrets. These are wading birds of the heron family.

In the predator class in this region are some of our most interesting animals — coyote, mink, weasel, bobcat, fox, snakes, owls, and hawks. It is true that small mammals and birds, including poultry, are sometimes killed by predators, although claims of damage to domestic fowl are frequently exaggerated. Yet small sacrifices may be necessary for the sake of larger gains. Predators maintained in moderate numbers serve not only to put pressure on surplus small-animal populations, but also keep the woods free from dead animals, and eliminate the weak and the unfit. It is unfortunate that various control activities are often applied so assiduously as to result in near-extermination of predators. These native animals are part of our heritage, they add zest and color to the outdoors, they help regulate the biological community, and they deserve a place.

Longtime fluctuations in climate, seasonal weather conditions, and use to which land is put by man all help determine wildlife numbers and the species present in an area. Effects may be drastic when changes occur suddenly as in a forest fire, an early freeze, or other natural catastrophe.

One of the pleasantest requirements of controlling wildlife populations, at least to thousands of fishermen and hunters, is the regulated harvest. By removing part of the natural increase, numbers are kept within the limits that the habitat is capable of supporting. This is the principle of *sustained yield.* If wildlife is to be maintained in a healthy, vigorous condition where habitat is limited, harvest is not only desirable but essential.

In recent years, automobiles have killed increasingly larger numbers of deer and other animals on highways. This has become such a significant factor in controlling deer populations that some conservation departments use the kill figures as a check on census estimates of animal numbers.

Changes in Wildlife Habitat

The original forest of the central region provided favorable environment for wildlife. It is somewhat difficult today to comprehend the variety and abundance. Practically all the land was used by wildlife. There was dense forest, woodland with natural openings, extensive marshlands, and tall-grass prairie — types which furnished a diversity of food and cover. There was plenty of water in clear-running streams. The forest provided great quantities of browse, nuts, acorns, berries, and seeds. Predators flourished and

helped to maintain a balance between animals and food supplies.

As settlement pushed westward the natural cover disappeared and some species of wildlife succumbed to civilization. Passenger pigeons and some other birds were exterminated. Various mammals disappeared from the region — elk, otter, cougar, wolf, black bear, and bison. Many species were sharply reduced in numbers, such as ducks, geese and other waterfowl, grouse (ruffed, sharp-tailed, and pinnated or prairie chicken), woodcock, bobwhite quail, bobcat, muskrat, mink, badger, beaver, and white-tailed deer. Raccoon, skunk, gray squirrel, and weasel apparently held their own. Certain species of the open country are even more abundant today, such as fox, cottontail rabbit, opossum, and fox squirrel. Cities have increased the robin population.

Sassafras and persimmon trees are taking over this abandoned cornfield. A pronounced change is occurring in wildlife habitat.

Wildlife probably reached its lowest ebb in the 1920's. Since then the central region has shared in the national upswing of interest and action which arrested the trend and in some cases gave rise to relative abundance of wildlife once more.

Game range in the central states is still losing ground to tilled-land agriculture, pasturing, burning, urban expansion, commercial development, highways, airfields, and power lines. Silt and other pollution loads in streams grow larger.

Shrinkage in forest acreage accounts for considerable loss of habitat, but this is only part of the story. The remaining woodlands have been so burned and overcut and overgrazed that only a small fraction of their potential is capable of being utilized by most wildlife

species. The present woodland is fragmented into small tracts that are congenial for only a few species; and millions of owners have diverse and often conflicting ideas as to the function of woods, many with little or no appreciation at all of wildlife values.

Draining wetlands to make them useful for farming has rendered an extensive acreage worthless or nearly so for migratory waterfowl such as duck and goose; for marsh and shore birds such as grebe, heron, bittern, plover, sandpiper, tern, certain hawks, and various songbirds; and for muskrat, mink, and beaver.

Canada geese over a game refuge in Illinois.

Pollution is greater on the whole in the central region than anywhere else in the nation. As an illustration, in the Ohio River basin about ⅗ of the population lives in communities where untreated sewage results in pollution; and waste is treated in only about half the industrial sources of pollution. Someone downstream always pays the cost of pollution — directly in higher charges for treating the water to make it usable for homes and industries, indirectly in vanished commercial or sport fishing, ruined wildlife and recreational values, and water of impaired quality for stock watering or irrigation.

There is no way of course to estimate the total loss in wildlife from habitat depletion. But it would be shortsighted to think of it as a loss merely in quantity. As in the case of our timber, it is also a loss in quality. This is demonstrated in experiments show-

ing that raccoons from areas of good soil are heavier than those from areas of depleted soil. We have fewer species than the habitat used to support and is still capable of supporting, even today, and some of these species are of a less desirable kind. A change from 50 deer or elk to 100 rabbits cannot be considered a gain simply because the number of animals has doubled and a lot of people enjoy hunting rabbits. On the other hand, it must be recognized that some species are not compatible with modern civilization. Wide-ranging animals such as the wolf, cougar, bison, and elk, cannot return to areas of dense human population and intense agricultural use. Such species as deer, grouse, rabbits, and squirrels, however, can thrive if some consideration is given them in land-use planning.

Improving Upland Habitat

Restoring habitat in the central region on a scale sufficient to be of much significance would be a complex undertaking and far beyond the present readiness of the people. But considerable progress has been made and the possibilities in this direction are promising. While state conservation departments[1] are responsible for the regulation of *animals,* only the landowner, public or private, can carry on, or authorize, habitat improvement on the *land.*

Nearly all the land in the central region suitable for crops has been put under cultivation. There are also thousands of acres now in low-yielding annual crops on hilly land, or on sterile, rocky, or claypan soil, which would serve a more useful purpose if they were in natural vegetation. Drained bottomlands, potholes, and marshes all offer possibilities for reconversion to wild land if the principle of "every acre to its best use" is applied. Many drainage projects have been unsuccessful or have deteriorated; habitat could be developed merely by allowing natural cover to become re-established. There are estimated to be 75 million acres of cultivated cropland in the United States which should be converted to permanent vegetative cover.

Over 600,000 acres of wildlife habitat have been added through the establishment of forest plantations in the 4 states. This is just

[1] Illinois and Indiana each have a "Department of Conservation;" in Iowa the comparable agency is the "Conservation Commission," and in Ohio the "Department of Natural Resources." Responsibilities are quite similar and the expression *department of conservation* or *conservation department* is used here as a general term applying to all 4 states. For clarification of conservation organizations and agencies see Appendix.

a beginning, however, as foresters estimate that some 4½ million acres are still in need of planting — about 2½ million acres in Illinois, over a million in Indiana, ½ million in Ohio, and 650 thousand acres in Iowa. Completion of a planting job of this size would give wildlife a tremendous boost, particularly since conifers, providing needed variety and valuable cover, would be planted almost entirely. Some wildlife species would be adversely affected after the trees matured, but others would be benefited. Ordinarily the plantings would be in relatively small units and would not have the disadvantages for wildlife that large blocks of heavy timber would have.

White-tailed deer drinking from pond constructed for use by wildlife.

Fire must be kept out of the woods if the necessary food and cover for wildlife are to be maintained.

In heavily-grazed woods — and this includes nearly all farm woods in the region — tree reproduction, browse, and herbaceous vegetation are eliminated by the foraging of livestock. Such areas are virtually useless for most species of wildlife and do not yield continuous crops of timber. They should be fenced so that instead of resembling a pasture cluttered with too many trees, a true woodland condition can be maintained.

Most of the advocated soil-conservation practices will benefit wildlife, many of them directly. Helpful practices include grassing of waterways, stabilizing streambanks, and planting living fences with such species as redcedar and multiflora rose to take the place

of clean fence rows. Windbreak plantings may be useful for wildlife, if made dense enough and wide enough.

Sometimes the border between woods and field or pasture can be coverted to shrubby growth (known as edge) which will be more useful for wildlife than either the woodland or the open ground. Borders of fields or woods can be left uncultivated to grow into edge, but a more permanent and far more valuable cover can be created by planting along the margin such shrubs as highbush cranberry, hazelnut, bush honeysuckle, dogwood, and coralberry. Planting stock of the useful shrubs can be obtained from commercial nurseries and from state conservation department nurseries. A good food species for bobwhite quail is the perennial legume, *sericea lespedeza* (or *bicolor lespedeza,* depending upon location). Food patches of buckwheat, millet, corn, sweet clover, or soybeans may be planted for use by game.

A food patch of soybeans and millet planted for wildlife in Ohio. Squirrels, rabbits, ruffed grouse, bobwhite quail, and deer all make use of this food as well as many non-game species.

In cutting timber, logging slash (debris) can be left on the ground or thrown into piles instead of being burned. The same principle applies to corn shocks, weed patches, fence rows, and fence corners — "clean" farming is an enemy of wildlife. Any

system of timber cutting which creates partial openings will be more beneficial than either a light cutting of selected individual trees or a clearcut which removes all trees, because low vegetation will be encouraged in the openings without destroying the woodland's essential character.

The private landowner is interested primarily in making a living and cannot usually afford to make large expenditures solely for improvement of wildlife habitat. A most important step in preservation or improvement of wildlife habitat is, therefore, education of landowners to convince them of the benefits. In many instances protection and improvement of wildlife habitat not only results in more abundant wildlife but also produces other tangible values. It is always good business for a farmer to conserve his soil and build up its fertility. Proper land use is also usually compatible with wildlife production. A diversified pattern of use in which flat and gentle-sloping areas with fertile soils are used for cultivated row crops, hilly land and sandy and gravelly soils for permanent pasture or hay, and steep slopes for woodlands provides a broken-up pattern of vegetative types that produces edge and is conducive to high wildlife populations. This type of use also conforms to the principle of "use according to land capabilities."

Another example of profitable land use that also benefits wildlife relates to preservation of wetlands. Some landowners have discovered that retaining marshes and ponds is more profitable than draining them. Inland marsh areas may be important as catch-basins for flood waters. Water from rains and snowmelt is retained and through slow seepage may help to keep the farmer's well from going dry, and the groundwater under the land may help to keep his pastures green. In addition, a suitable habitat is provided for waterfowl and muskrat.

Improving Aquatic Habitat

The animal world of aquatic habitats rests upon a base of plants, as does life everywhere. As an example, plants are eaten by insects, the insects supply food for bluegills, and the bluegills are eaten by bass. Such "food chains" are common in nature.

Like upland habitats, aquatic habitats will be used by animals best adapted to the existing conditions of food, cover, and climate, and the most favorable conditions usually will support the largest

populations. Regulation or treatment can be applied to both the animals and their environment.

Direct methods of controlling aquatic animals and upland animals are similar — setting legal seasons, establishing size and bag limits, declaring areas open or closed to fishing, hunting, and trapping. "Rough" fish (undesirable species) may be seined to reduce their numbers, or, in artificial ponds, the water may be drained and restocking done with desired species. Ponds may be poisoned with rotenone to kill all fish present and then restocked with desirable fish. The state conservation departments have full responsibility for such controls.

Indirect methods of control involve the treatment of aquatic habitat. For instance, steps are frequently taken to improve the quality, temperature, and oxygen content of water, making it a better habitat for game fish and the plants and animals upon which they feed. Approaches such as the following are commonly used to improve aquatic habitats:

Planting trees and shrubs
Grassing waterways
Acquiring miscellaneous parcels of land to make possible unit-area management by the public
Fencing to exclude livestock from streambanks or plantings
Sowing seed or setting out aquatic food plants
Using herbicides to kill aquatic plants when in excess or of undesirable species
Fertilizing waters
Dredging or damming to increase water depth
Controlling pollution and sedimentation

Watershed improvements will be of little value to game fish and birds unless pollution is controlled. Wastes in water may be harmful or lethal because of their direct toxic effects; in addition, sewage uses up large quantities of oxygen as it decomposes, making it difficult or impossible for aquatic animals to survive.

The Future of Wildlife

It is biologically impossible to produce enough wildlife to satisfy the more enthusiastic sportsmen and vacationists, but there is room for more variety and larger numbers if habitat is extended and improved. According to Census Bureau forecasts, population in the United States will increase at least an additional 30 million in 20 years. We may have 25 percent more people than we have

now, within the short span of 2 decades. This will intensify hunting and fishing pressure and result in corresponding demands for use of farmers' woodlands.

One of the most difficult problems in wildlife management today in our region is that of improving relations between sportsmen and farmers. A large area of potential fishing and hunting ground is unavailable because the landowner has posted it with "No Trespassing" signs in an effort to protect his property. Nearly all sportsmen value their privileges, but a few individuals have created ill will by leaving gates open, breaking down fences, damaging crops, setting fires, and even shooting livestock or insulting landowners on occasion. Opening posted land is one means of relieving hunting and fishing pressure, and no step should be overlooked which will bring farmers and sportsmen closer together. This approach holds fully as much promise as improvements upon existing habitat.

Hunting for bobwhite quail — an important game bird.

In some respects, remarkable progress has already been made in bringing wildlife back. Deer have recovered in the central region to the stage where Ohio and Indiana were recently able to permit deer hunting for the first time in modern history. In 1953 Iowa had its first open deer season in 75 years and it was a most successful one. There is always some criticism directed at conservation departments for permitting hunting after long periods of protection, particularly when open seasons on female deer are

instituted, for fear that game will be exterminated. There are pressures to open seasons when farm crops are being damaged by game animals. It is also apparently inevitable that misinformed groups occasionally will seek to repudiate the principles sponsored by resource managers, thus turning back the clock. At critical times, real conservationists must be alert, informed, and ready for action.

Pressures on forest land are growing stronger and it will require continual vigilance, effort, and money to maintain wildlife levels. Competition for the use of land is already keen in some localities. Many acres of well-developed farm land pass into the urban category every day. The tendency will be continually to push back and "civilize" woodland to meet the demand for space that is generated by great populations. Wildlife habitat can be saved, or created, by informed citizens, aided by the knowledge and guidance of professional conservationists.

6

FOREST RECREATION

Recreation Resources

Outdoor recreation is usually associated with woodlands and their streams and lakes. While many residents of the central states visit the cool northern forests in midsummer, local vacation spots are heavily used 5 months of the year, particularly on weekends and holidays.

The last 20 years have seen a growing interest in outdoor recreation, and as long as high levels of income and employment prevail, with corresponding leisure time, there is little likelihood that it will diminish. Even though less prosperous times should arrive, it is probable that residents would give up more distant trips for vacations nearer home, increasing the pressure on local facilities still more.

The relentless increase in population in the United States is sure to bring additional millions to the outdoors. The country finds itself as unprepared in the field of recreation to cope with the onrush of population as it is in problems connected with highways, schools, city traffic, and parking. How to provide large numbers of people with facilities for enjoying the outdoors is a problem for the public at large. Dumping it in the laps of recreation administrators will not solve it.

The supplying and servicing of tourists, local recreationists, and sportsmen has become an important business in some parts of the central region. Much of this activity centers around the state parks and forests and the national forests.

In Iowa there are 18 state parks comprising 15,022 acres. In addition, 81 other tracts are reserved for recreation. The most popular areas are Lake Manawa and Clear Lake. Among the well-wooded parks are Lake Ahquabi, Ledges, and Springbrook.

State parks in Illinois number 33 and extend over 26,098 acres. Chain O'Lakes, Giant City, Kickapoo, and Starved Rock are well-known woodland parks. Of particular interest in forest conserva-

tion is White Pines State Park, where a grove of virgin white pine exists, one of the few in the central region.

Indiana's larger recreation areas include Versailles, Tippecanoe River, and Brown County State Parks, all of which are forested. Other woodland parks are Muscatatuck, Shades, and Turkey Run. There are 18 parks in all, with a total of 46,213 acres.

In Ohio there are 16 state parks, covering 22,074 acres. The largest is Pymatuning Reservoir State Park in Ashtabula County. Most of Ohio's parks are wooded, some of them, such as Hueston Woods and Rocky Fork, representing sizable areas of undeveloped land.

There are also a number of county and municipal forest parks. The largest is Cook County Forest Preserve, an area of nearly 40,000 managed acres of native vegetation on the outskirts of Chicago. Others such as Virginia Kendall Park in Akron, Ohio, are well known locally.

The national forests are important recreation areas. In Shawnee National Forest in southern Illinois, about 400,000 people a year stop to enjoy the forest; Hoosier National Forest in southern Indiana has 90,000 annual visitors, and Wayne National Forest in eastern Ohio about 60,000. The best known national-forest recreation area is on Lake Vesuvius in Ohio.

"How to provide large numbers of people with facilities . . ."

There are no national parks in the 4 states, but there is a national monument in Iowa (Effigy Mounds) and one in Ohio (Mound City).

Recreation Activities

Fishing ranks as the principal sport in the region with hunting second. Together these activities represent a sale of nearly 5 million resident licenses a year. Illinois is one of the leading states in the nation in licenses sold, and is closely followed by Ohio, with Iowa and Indiana not far behind. Illinois is also a leading state in sales of duck-hunting licenses. The number of persons who engage in fishing and hunting in our 4 states exceeds the total population of Indiana. These sportsmen, however, represent less than 25 percent of all recreationists.

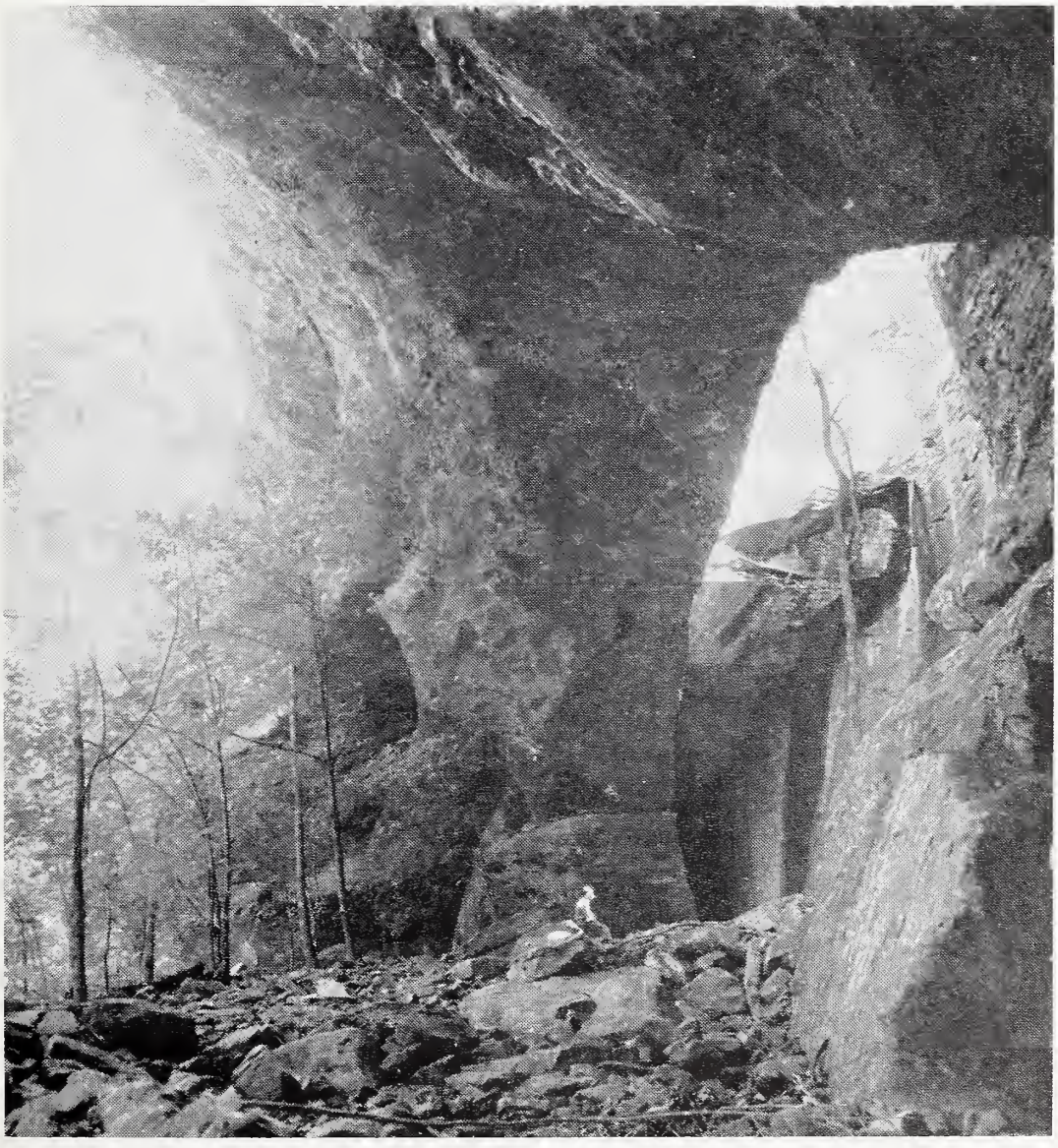
Fishermen have the opportunity to catch northern pike, bass, bluegill, catfish, crappie, walleye, bullhead, and trout. Hunters may bag bobwhite quail, squirrel, rabbit, pheasant, grouse, fox, raccoon, white-tailed deer, duck, and goose.

Snow conditions are not reliable enough to arouse much enthusiasm for local skiing, but fishing through the ice, and skating, are popular. Some areas provide opportunities for hiking, canoeing, and river "float trips" in small boats.

Woodland stream — an important recreational resource.

The national forests and most state parks have facilities for tent-camping. These consist of family units with auto-parking space, fireplace grate, and bench-table. Water outlets and sanitary facilities are provided. In a number of locations, permanent camps have been constructed. These range in size from a few cabins to accommodations for a hundred or more persons complete with dining and recreation halls and sleeping quarters.

Small campgrounds may be used free, but a nominal charge is made at some of the larger developments. Length of stay is limited usually to 2 weeks. Where cabins are available they are rented to groups or families on a weekly basis. The large camps are rented to religious, civic, and youth groups. In public areas such services as bath-house privileges, boat rentals, and sale of food and beverages are furnished by concessionaires who operate as private business under supervision of caretakers or rangers.



Recreation area in a national forest.

A number of small roadside parks or "waysides" have been constructed for the convenience of the motor traveler. Bench-tables for picnicking are provided and occasionally grates and water taps. Roadside parks are usually maintained by the state highway departments, occasionally by the county or municipality.

Highways offer opportunities for enjoying the attractive landscapes of the midland region. The scenic routes are provided with outlook points which open upon vistas of forest and water. Some of the more attractive areas are within the national-forest sections of southern Illinois, Indiana, and southeastern Ohio. For scenic tours, two seasons are popular — April, when redbud and dogwood are in bloom, and October, when brilliant autumn foliage is on display.

Education Outdoors

Forests offer a fine opportunity for teaching conservation. Fortunately in this region no school is far from woodland of some kind. The possibilities of the outdoor environment, however, are exploited all too rarely, due to lack of confidence on the part of the teacher, inflexible periods, lack of administrative support, transportation difficulties, inability to dissociate learning from the classroom, and other problems, real or imagined.

Pupils in 4th, 5th, and 6th grades in camp.

Education in the outdoors would be attempted more frequently if larger numbers of teachers could be exposed to good instruction in conservation. Relatively few have had the opportunity to learn of the possibilities for enriching the curriculum provided by the dynamic subject matter of conservation. While more teachers are being reached than there were a decade ago, considering the increase in numbers of teachers on the job, the percentage receiving instruction is probably no greater, and after annual turnover is taken into consideration it is questionable whether there is any net progress.[1]

Camps operated by school systems provide an opportunity for full-scale conservation teaching when they are properly administered. If the program stops at the level of recreation, nature study, and handicraft, however, it can hardly be called conservation education. Outdoor camping with the school or the grade as a unit has been pioneered by a few school systems in the central region. Such youth groups as 4-H and Future Farmers of America have conducted camps for many years, stressing principally soil conservation.

[1] Anyone wishing to associate with the national movement may join the Conservation Education Association, 31 North State Street, Chicago 2, Illinois. The membership is $5.00 a year, $2.00 for students.

A school forest can serve as an outdoor laboratory for study, particularly when it is close at hand.

Summer camps for teachers are maintained in each state through cooperative effort of the state departments of conservation and of public instruction, and state colleges or universities. The principal teacher-education camps are located at Leesville Lake, Ohio; Versailles State Park, Indiana; Fox Lake and Springfield, Illinois; and Springbrook State Park, Iowa. These camps all offer college credit.

A fertile field for conservation education is found in camps for boys and girls. According to the American Camping Association, there are in the neighborhood of 700 such camp properties in our 4 states, with well over a third of them in Ohio. Approximately 900 separate groups attend these camps. Conservation concepts can be introduced into the conventional camp offerings by any director who has a genuine desire to teach appreciation of natural resources in his program.

One important phase of conservation education involves learning how to behave in the woods. It concerns a fundamental attitude, the development of which can be started in the primary grades. Common acts of carelessness include polluting water; defiling toilets and campsites; defacing trees, buildings, fireplaces, and tables; scattering garbage and debris at picnicgrounds; throwing rubbish out of cars; disregarding fire-prevention rules. Policing and maintenance not only add to the taxpayers' bill, but require diversion of funds for repair and cleanup that are needed for more constructive purposes. "Litterbugs" have been estimated to cost federal, state, and county governments nationwide a total of over $30 million a year in cleaning up our forests, parks, highways, and beaches.

Another phase of forest living is the practice of safety. Hazards are plentiful in the woods and around water, and the chances that an accident will prove serious are multiplied because medical or surgical help is usually some distance away. Safe methods in camp, on the trail, in canoes, and in handling firearms can be learned through demonstration and practice.

Outdoor good manners can be learned in school, at camps, and on group or family outings. Youngsters can then teach their parents and their friends. Everyone can participate in the first lessons in conservation.

Recreation Management

In an area dedicated to recreation as the primary use, considerable skill and technical knowledge are needed for effective management. Decisions must be made based upon accumulation and analysis of facts. A map showing types of cover and land uses is one of the first requirements. After a survey and inventory of the management area, the answers to such questions as these can be incorporated into the plan: What purposes is the area expected to serve? Will timber be cut, and if so, how much, where, and with what protection of recreation and scenic values? May roads be constructed, and if so, what type, and where? What structures, such as resorts, summer homes, docks, auto courts, and public camps, will be allowed, and what standards of construction will be set up? What fence construction, if any, is necessary? What areas will be developed and which shall remain undisturbed?

In a state park, Indiana. One of the objectives of recreation management is to keep such areas in a natural condition.

Timber cutting, in areas where recreation use is dominant, should usually be restricted to improvement cutting for aesthetic purposes, with the timber cut considered only as a by-product. Normally, in heavily-used recreation areas and in roadside and waterfront zones, the only cutting permitted should be that which benefits recreation. However, within areas where recreation occupies an

equal or subordinate interest with other major functions and uses, timber cutting can be carried on with limited conflict, provided it is judiciously planned.

Grazing should be prohibited in woodlands and in areas used by recreationists. Pastures within recreation areas should be well fenced.

Wildlife habitat can be preserved in recreation areas with few, if any, special provisions. Certain species of wildlife actually develop a special tolerance to human beings — for example, opossum, deer, squirrel, quail, racoon, and many birds and waterfowl.

Well-planned and carefully-administered recreation use has no adverse effects upon water yield or streamflow. However, if use is concentrated too much, pollution may occur, and compaction of soil and depletion of vegetation may result in erosion.

Aesthetic and scenic values can be protected if there are adequate laws and ordinances, and public support of them. The rural landscape can be preserved through *zoning,* a system of use based upon land classification. The worth of this method has been well demonstrated in Wisconsin. When zoning is applied, individual interest becomes subordinate to the welfare of society. The "greatest good of the greatest number in the long run" as a principle of conservation seldom reaches a higher form of expression.

The pines were planted as a roadside improvement. The tops have been cut off so that the advertising signs will be visible. The warning "Careful With Fire" provides an ironic touch.

The principal attraction of the forest is its "differentness" from urban environment. Past experiences point up the wisdom of making every effort now to preserve attractive segments of the outdoors and vestiges of wild land for the enjoyment of all and to insure that they will not be despoiled and over-tamed. Salvage later is always a hard road, an expensive one, and never entirely adequate.

Conservation owes much to alert citizens whose primary interest in recreation led them to support a broader program. Recreation-minded users of the forest are enthusiastic and wield considerable influence. They have the responsibility, therefore, of keeping well informed on conservation problems and of weighing the contributions forests make in raw materials for industry. On the other hand, those concerned with economic values must keep in mind the inner satisfactions, improved health, and relief from mental and nervous tensions provided by forests, and see to it that aesthetic factors are preserved. Forests and woodlands serve man in many ways and no yardstick has been devised that will determine the most important benefit.

7

PROTECTING WOODLANDS

The principal causes of damage to woodlands are grazing, fire, destructive cutting, insects, diseases, and storms.

Grazing

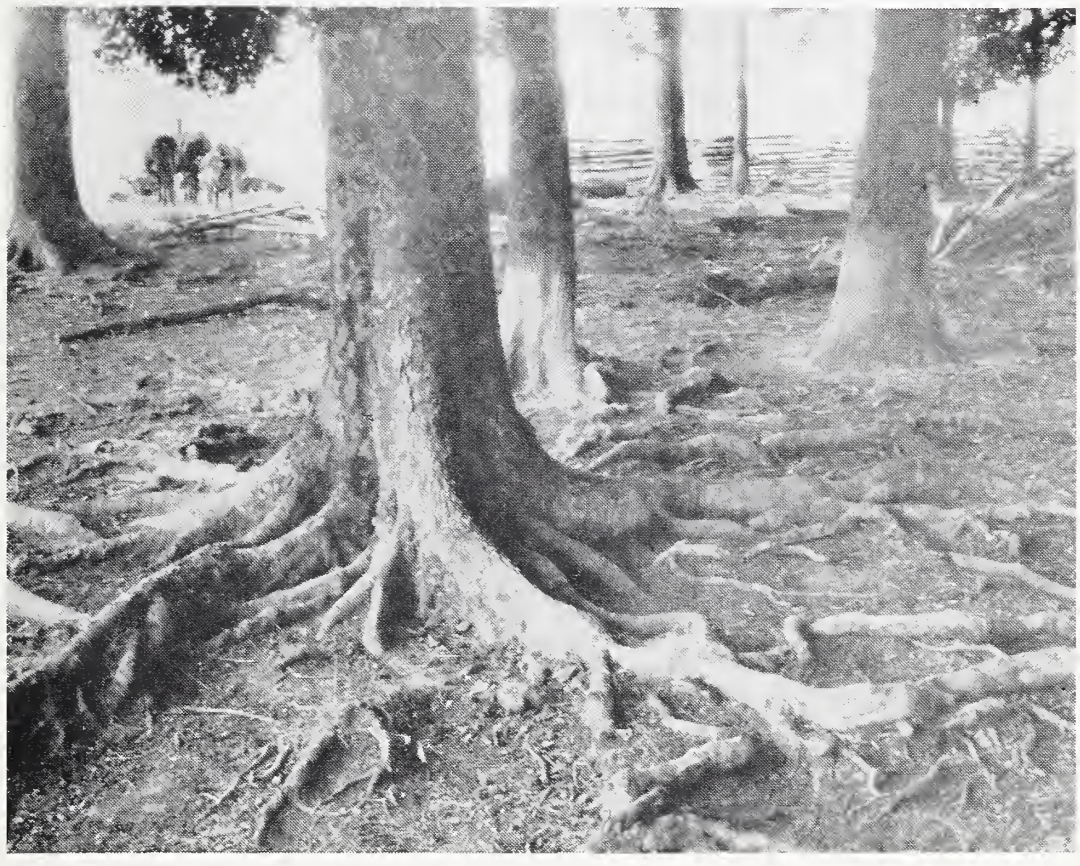
In the coniferous forests of the West, with their many grassy openings, grazing causes only occasional and minor damage to trees. In our central region, however, woodlands are probably damaged more from grazing than from any other cause, although fire is more important in the southern portion. The widespread practice of allowing livestock to graze the woods along with open pasture can be attributed to several factors: woodlands are composed almost entirely of hardwood species, the young growth of which is relished by livestock; there is a large livestock population on farms, with corresponding pressure upon pasture; the timber value of woodlands is underrated while their forage value is overrated; woods furnish shade in hot weather.

In Iowa about 84 percent of all woodland in the state is pastured, according to farm census figures; in Illinois about 63 percent; in Indiana 60 percent; and in Ohio 38 percent. Pasturing is most severe in the zone of small scattered woodlots. From the figures cited, one might well conclude that grazing is at work reducing the total timber-growing potential of the woodlands of the region by ⅖ to ⅘ of the present capacity. Any gain in new shoots that escape death from overbrowsing is being offset by damage to roots and humus, and by reduction in growth and in quality of the stand.

If 38 percent to 84 percent of the woodland in these states were consumed by fire in one catastrophic year, the impact upon the public would be swift and certain. The results of grazing are as final, yet because the process extends over a period of years it escapes attention.

Studies showing the effect of grazing on woodlands prove that "Cows make poor foresters and woodlands make poor pastures." For example, in one experiment, beef cattle grazing only woodland

forage had to be supplied with supplemental feed in order to prevent loss of weight. Litter in an ungrazed woodland was found to be over 4 times as deep as that in a similar woods grazed by livestock. Differences in runoff were demonstrated by tests in which a simulated rainfall of 1.4 inches per hour was applied to similar clay-loam soils. This resulted in no surface runoff from an ungrazed bluegrass pasture, while a heavily-grazed pasture lost in runoff about ¾ of the "rain." Tests showed soil upon which grazing occurred to be 5 times as dense as soil of an ungrazed area. The difference in soil density (an indication of porosity) therefore seemed to explain the soil's ability to absorb water or reject it.



". . . damage to roots and humus."

Unfortunately, our most valuable hardwood tree species are the ones that livestock like best. Continued grazing pressure upon valuable species results in reducing their proportion in the stand or in eliminating them entirely. Studies have shown that species browsed heavily under all conditions are sugar maple, white ash, basswood, red elm, white oak, red oak, American elm, and yellow-poplar. Any list of desirable hardwood species from a forestry standpoint would surely include these. On the other hand, even under heavy stocking with livestock, hawthorn, blackjack oak,

persimmon, hornbeam, and hophornbeam—all low-value species—were found to be seldom browsed. The quality of the stand must inevitably decline under such a selection system.

Clearly, if land is to be devoted to timber production, livestock must be fenced out. Usually the slight loss in forage value due to fencing can be compensated by improving the field pasture. If shade is needed, a fringe of woods can be fenced into the pasture. If the soil of a woodland is found to be much more valuable for cultivated crops, or if the woods have been reduced to an open park with packed soil, the trees should be cleared off.

Showing open, parklike character of grazed woodland. Tree seedlings are nowhere in evidence.

Deer may cause damage to plantations and woodlands by browsing. As yet deer are not numerous enough to create a problem, but sufficient examples exist in the Lake States and elsewhere to show that once deer are established on an upward trend, herds increase with astonishing speed and may outrun their forage supplies. Browse plants are killed off under heavy grazing and starvation ensues. Herds must then be reduced to a point at which available browse can support them in *winter* after the leaves have fallen. Proper numbers must not be determined on a basis of summer feed, but rather on the worst conditions the herds are likely to face. When open seasons on female deer, the breeding stock, are found necessary, experience has shown the need for considerable preeducation of the public before reason can be led to outweigh sentiment.

Animals of the forest cause damage in other ways than by browsing. Beavers kill large numbers of trees, usually of low-value species, using the bark for food, and the branches in their dams and houses. Probably still greater damage is caused by the flooding of low-lying forest behind the dams. Porcupines eat the inner bark of conifers and kill trees by girdling them. Rabbits, squirrels, mice, gophers, and woodchucks all cause damage to woodlands. Their most serious depredations occur in plantations and nurseries, where they nip buds and branches, girdle trees, and kill young trees by uprooting them or by feeding upon the roots below ground. Grouse and grosbeaks may cause minor damage by nipping buds, particularly those of young red pine. Patrol with rifle or shotgun against seed- and bud-eating birds is necessary in large forest-tree nurseries.

In fairness, perhaps the well-known benefits realized from forest animals should be reviewed briefly. Everyone is familiar with the value of birds as consumers of insects. In 1952 the woodpecker was credited with contributing in an important way to the final control of the bark-beetle epidemic that swept the spruce forests of Colorado. The soil is cultivated, aerated, and fertilized by moles, badgers, pocket gophers, ground squirrels, woodchucks, and other digging and burrowing animals. Worms aerate the soil with their tunnels and enrich it with their castings. A great variety of insects and other animals, some of them almost microscopic, convert litter into soil nutrients. Large seeds such as acorns and nuts are planted by jays, squirrels, chipmunks, and mice. And who can evaluate the balance sheet when millions of moles and shrews have a diet consisting chiefly of insects, but also destroy small patches of vegetation by burrowing?

Fire

Fires have been responsible for great losses in the central hardwoods ever since the days of early settlement. Many woodlands have burned several times and some have been systematically fired over and over again. There was little effective fire protection before the 1930's and much of the intensive effort has come in the last decade.

Protection, however, doesn't keep fires from starting. In 1954 there were 2,336 fires in the 4 states and they burned an area equivalent to a strip one mile wide and 104 miles long, the distance between Ames and Cedar Rapids, Iowa; Springfield and Quincy,

Illinois; South Bend and Lafayette, Indiana; Columbus and Massillon, Ohio. The fires destroyed reproduction for future timber crops, neutralized much of the new forest planting, drove out wildlife for several years, set back for a quarter of a century the ability of the soil to regulate runoff and streamflow, burned farm buildings and crops. Ironically, taxpayers paid out millions of dollars for all this, in costs for fire control. Practically all of these fires were caused by careless people and could have been prevented.

Forest Fires in 1954

	NUMBER OF FIRES	ACREAGE BURNED
Iowa	18	1,110
Indiana	664	11,729
Illinois	456	42,156
Ohio	1,198	11,595

The principal cause of fires in the central region is what is called *debris burning* by protection agencies — the burning of fields, fence rows, trash, brush piles, and burning to clear land. Such fires frequently escape and become wild fires; they account for nearly 40 percent of our fires. Smokers are the next most important cause of fires. Other common causes are railroads, and incendiaries or deliberate fire-setters. Campers always cause a few fires every year.

Fire protection makes forest management possible. These young, planted pines have a good chance of reaching merchantable size.

Fire-protection plans are developed to focus attention on areas where the probabilities of fires starting are greatest and where the values at stake are highest. Studies of fire history, surveys of cover types, and good maps are essential to preparation of the fire plan. Property investments in buildings, forest crops, important watersheds, and communication lines receive highest priority in protection. Among the types of cover, forest plantations are usually considered most deserving of protective effort, because of the cost of establishing them. Dry grass and broomsedge are considered the most inflammable fuels. Dense logging slash is considered hazardous not so much as a fuel but because of the resistance to control presented by a thick tangle of debris. The number and severity of fires increases in general from west to east, with Ohio the most hazardous state and Iowa the least.

The spring forest-fire season normally extends from the middle of February until the middle of May. After the woods are fully leafed out, the fire danger falls. Sometimes bad burning conditions recur in late September after low-growing vegetation has "cured" and leaves begin to fall; the critical period may extend to November, with rain or snow ending the season. Peak months are March and April, occasionally October.

A system of evaluating burning conditions which was evolved by the Central States Forest Experiment Station of the U.S. Forest Service is in use by forest-fire protection organizations throughout the region. The system is based upon daily observations at selected stations of several factors that influence the start and subsequent spread of fires — condition of grass and shrubs (whether green, curing, or dead), amount of precipitation and interval since it last occurred, relative humidity, and wind velocity. A combination of these observations is mechanically translated on a pocket-size scale called a fire-danger meter into a *burning index.* The burning index indicates one of seven classes of danger and guides the fire-control officer as to hiring of extra men for crews and emergency lookout towers, suggests whether the fire organization should be placed on an "alert" basis, whether forest roads should be closed to the public, etc.

A fire must be confined before it can be extinguished. The spread can be stopped by robbing the fire of either fuel or oxygen. Fires in dry broomsedge, grass, weeds, or leaves may be *knocked down* or *corralled* by cutting off the oxygen supply, using beaters or wet burlap sacks at the edge of the fire. A *fireline* is then constructed

around the edge of the fire to make it safe. A fire is said to be *controlled* or *under control* when a fireline has been completed around it.

Heavier fuels cannot be controlled by cutting off the oxygen supply as in the case of grass or broomsedge. Instead, a fireline must be built to separate the burning area from fresh fuel. This is accomplished by removing all inflammable material along the edge of the fire. Since humus in the topsoil layer will carry fire, the fireline must extend down to mineral soil. All leaves, branches, and other fuel in a path from a foot to several feet wide must be cleaned out. When the fire reaches this line its spread will stop for lack of fuel.

Fast-running fires frequently jump the fireline making a re-adjustment in attack necessary. Fires of this type can sometimes be stopped only by cutting off fresh fuel through a technique called *backfiring* in which a counter-fire is started between the main fire and a well-constructed fireline. The backfire must burn toward the main fire against the wind and the operation is therefore used sparingly as it may in truth "backfire," starting a new conflagration.

In building a fireline, heavy equipment such as bulldozers, or tractors pulling trenchers or plows, is often used. Hand tools commonly employed on woods or brush fires consist of crosscut saws, axes, grub hoes, shovels, rakes, and pulaskis. The pulaski is a common fire-fighting tool with a dual-purpose head, in one piece, consisting of ax blade and grub hoe.

Fire fighters usually do not rely upon water to control forest fires of any size. Water can seldom be provided in quantities large enough or along a wide enough front to stop a moving fire because of the difficulty of hauling it and the lack of means to apply it in quantity in the right location at the proper time. Water is used principally in 2 ways: to cool off "hot spots" so that men can work closer to the fire when building a fireline, and to *mop up* or extinguish a fire after it is controlled. A variety of powered pumpers, tankers, and tank-trailers have been developed, and hand pumps are frequently used. Some of these devices are portable, some semi-portable such as the pump units which slip onto the bed of pickup or truck, and others are pump-and-tank units permanently mounted in a vehicle.

In Indiana an interesting plan has been set up for the training of young fire fighters. Boys and girls are enlisted as volunteers in the Forest Fire Fighters' Service, organized into crews and, when

a state officer is in charge, are used to control woods fires. They receive training in firefighting methods as coordinated crews. The FFFS was started in 1942 in Indiana, making it the oldest such organization in the United States. Since its inception, about 30,000 young people have been trained.

The principal fire-protection agencies are the divisions of forestry in the state departments of conservation, and the U.S. Forest Service. For detecting and reporting fires when they are small, these protection organizations depend principally upon lookouts, planes, and volunteer reporters such as farmers, woods workers, and tourists. Two-way FM radio, and telephone lines, form a flexible network of communications. The regular fire organization is always supplemented in the central region by part-time local wardens who are employed as needed.

A modern plow constructing a fireline 45 inches wide. With a small tractor it forms a compact, portable unit that can be loaded on a 1 ½-ton truck.

Our 4 states spent $590,806 on fire protection in 1954, in a cooperative program under the Clarke-McNary Law of 1924 in which the federal government contributed $164,833 with the U.S. Forest Service acting as partner.

For those who desire additional information on fire-control organizations, a special section will be found in the Appendix beginning on page 123. The discussion covers the systems in use by each of the 4 states and in the national forests.

Destructive Cutting

Harmful cutting practices take 3 principal forms in this region: (1) *Cutting good-sized, fast-growing trees* — "decimation of the stand." From a forestry standpoint, trees over 12 inches d.b.h.[1] in good condition should be left standing if they are still growing rapidly; however, they are commonly cut, without taking growth rate into consideration. Low-value smaller trees should be removed, but usually are not because they have little sale value. (2) *Cutting only sound, clean trees and leaving culls* — "impoverishment of the stand."[2] This yields higher immediate financial returns, but profits soon end. The practice is somewhat comparable to exploiting soil fertility without providing for its replacement. (3) *Cutting only the most valuable species and leaving undesirable species* — "degeneracy of the life stream" — the opposite of "breeding up" in livestock management.

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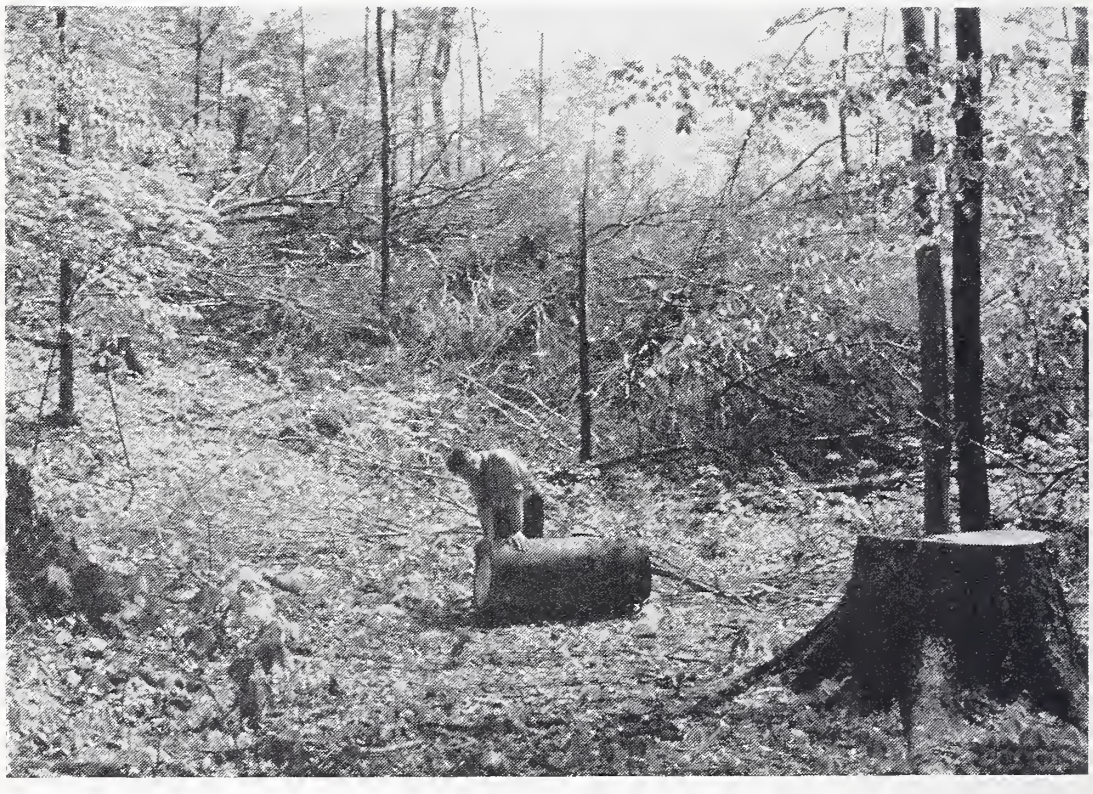
[1] d.b.h.: diameter breast high, a point 4½ feet above the ground at which foresters commonly measure diameters.

[2] Cull tree: live tree at least 5.0 inches d.b.h. Not merchantable as sawtimber now or in the future because of species, poor form, limbiness, rot, or other defect.



Destructive cutting, showing mass of debris and broken timber in background. The clearest lumber is obtained from the lowest part of the tree; waste is evident here in the butt section left in the woods (being examined by the man), and in the high stump.

Usually all 3 types of malpractice are carried on simultaneously. The process has been aptly described as "skimming the cream." The condition of the present stands can be imagined by recalling that this sort of cutting has been going on steadily for about 75 years. In the woodlands that remain the cream is getting thin. In many instances the forest has been eliminated. To the untrained eye "trees are trees" and the woods today look adequate enough. Unfortunately, the trend is far from arrested. Thousands of acres each year, chiefly in farm woodlands, are passing to a status of law productivity because of bad cutting practices. (A review of good forestry follows in chapter 10.)

Insects

Fire is a spectacular destroyer, grazing a slow, insidious one, but nationwide neither kills as many trees in a year as insects and diseases. Upon occasion insects and diseases have moved swiftly to destroy forests. They are capable of wiping out forest areas extending over several states and have done so many times. Fortunately, most insects and diseases are selective, attacking only one species of tree and its close relatives. Young, healthy trees are usually able to ward off attacks, but overage and weakened trees are susceptible.

Insects may attack any part of the tree — roots, stem, bark, branches, leaves, and buds, and some species eat seeds. One of the most destructive types is the borer which works beneath the bark. It may girdle the trunk and kill the trees by severing the transportation system in the inner bark. Examples of borers are the several species of bark beetles which have decimated pinelands in the West and South. The hickory bark beetle in the central region is of this type, but of minor importance. The cottonwood borer and locust borer are common in our region. These insects penetrate the wood. Even when they do not kill, borers cause a slowing in growth rate, weaken the wood, and lower its value.

Another type of insect defoliates the tree. Death may result if defoliation occurs several years in succession. Defoliators of this region include spring cankerworm, red-headed pine sawfly, Japanese beetle, locust leaf miner, and various caterpillars and webworms.

Other insects attack buds and twigs, particularly those of young trees in nurseries and plantations. In this group are the European pine shoot moth, dangerous to red pine, jack-pine sawfly, white pine weevil, and numerous aphids and tip moths. The locust borer

frequently attacks locust of pole sizes in plantations established on poor sites. Scale insects attack the bark of trees and white grubs attack roots of young nursery stock.

Insects are always at work in the woods, attacking scattered individual trees or small groups. Special control measures are not justified in such cases, and it is often possible to remove attacked trees during logging operations, thus reducing the possibility of spread. Sometimes, however, an abundance of slash or dead timber, particularly in times of drought, provides such a favorable environment for breeding that insect numbers increase to epidemic proportions and spread over large areas of forest. Special control projects are then essential to confine the attack.

Larvae of red-headed pine sawfly feeding on needles.

Different kinds of insects require different methods of control. Removing and then burning infested bark, dusting or spraying trees with insecticides, cutting and burning infested tips, are all

common measures. A healthy, well-managed stand is a strong deterrent against an insect outbreak since vigorous trees are capable of withstanding attacks. Since logging slash and debris from fires and storms provide food and breeding grounds, often leading to epidemics, disposal of such material wherever possible is a good preventive measure.

Diseases

Like insects, diseases are a constant threat to woodlands. The chestnut blight killed all the chestnuts in eastern United States as no practical control could be found. Today oak wilt, Dutch elm disease, phloem necrosis, and white pine blister rust are potentially dangerous. Vigorous managed woodlands are good insurance against outbreaks of diseases as well as insects.

Probably our most dangerous disease at present is oak wilt. Like most tree diseases, oak wilt is caused by a fungus. Oak wilt first became entrenched in Iowa, Illinois, Wisconsin, and southern Minnesota. It has now been found in all states from the Great Plains eastward through the Appalachians.

All known oak species and a number of oak relatives have been found susceptible. No way of preventing the disease is known. Oak wilt kills species of the red-oak group quickly, usually within a year. White-oak species live for several years after being attacked. Symptoms of infection are wilting of leaves followed by "bronzing." The top of the crown is affected first.

Oak-wilt fungus is known to spread from tree to tree through interconnecting roots which join in "root grafts." However, spreading occurs also beyond the radius of roots, indicating transmission of the disease above ground in some manner as yet unknown. The only control method which appears feasible in the light of present knowledge is the isolation of infected centers to prevent spread of the fungus by way of roots. This may be accomplished by poisoning oaks in a buffer strip 50 feet wide around the infection center. Poisoning is accomplished by cutting through the bark and applying toxic chemicals to the transportation system of the tree. In the case of ornamental and shade trees, digging around the infected tree to a depth of 30 inches will sever interconnecting roots. This should be delayed no longer than 3 weeks after the first symptoms appear.

The oaks as a group are our most valuable hardwoods, and constitute 50 percent of the tree cover in some parts of the United

States. Foresters and industries dependent upon supplies of oak are concerned over the spread of oak wilt and are trying to find out more about the disease and how to control it. Owners of oak timber may one day suffer large losses. The general public will not be aware of this threat unless damage to parks and shade trees becomes more widespread.

Trees killed by oak wilt.

White pine blister rust also kills trees, but unlike chestnut blight and oak wilt, is a disease which can be more readily controlled. It is caused by a parasitic fungus that lives alternately on white pines and *Ribes* (pronounced rye-bees — the genus name for currant and gooseberry plants.)

Blister rust spreads by means of wind-borne spores that are produced during the spring, summer, and fall. It enters white pines through the needles and grows into the bark, forming cankers. These are exterior wounds caused by fungi; they have a girdling effect. As the disease progresses in the tree, the affected parts are killed. Eventually the whole tree dies.

This 20-year-old white pine is being killed by blister rust. The man is pointing to the canker, 16 inches long, that is girdling the tree 9 feet above the ground. The white exudation is resinous sap.

When the cankers mature, in about 3 years, blisters break through the diseased bark. It is from these blisters that the disease get its name. The blisters are full of tiny, orange-yellow, dust-like particles called *spring spores,* which are most abundant in May. When the blisters break, spores are scattered over large areas by

the wind. The spring spores cannot spread the disease directly from one pine to another. They carry it only from infected white pines to Ribes leaves. About 3 weeks after the spring pores become established on Ribes leaves, orange-yellow pustules appear on the under surface of the leaves. These pustules break open and liberate *summer spores* that spread the disease on Ribes from leaf to leaf and from plant to plant. In late summer and fall, brownish, hairlike outgrowths of the fungus appear on the under surface of the diseased leaves and produce fall spores that infect white pines. The *fall spores* are so delicate and short-lived that their infecting range is limited to short distances from diseased Ribes. This makes it possible to control the disease by destroying all Ribes within infecting range (usually 900 feet) of the white pines.

White pine grows well in the northern portion of the central region and is one of the principal species used in reforestation. It is a valuable and attractive species well worth protecting.

Disease often attacks the heartwood — the wood inside the sapwood — and causes decay. Such *heart rots* take a heavy toll in older trees, frequently gaining entrance through scars made by fire. Cankers on the lower portion of the stem cause losses in a great variety of hardwoods and in red pine. In nurseries and young plantations, a host of wilts, mildews, rusts, and molds, all caused by fungi, attack roots, stems, and leaves. Methods used to prevent and combat these attacks include chemical treatment of seed before sowing, spraying, dusting, and selection of resistant species and strains.

Agencies concerned with control of forest insects and diseases are principally the state departments of conservation and agriculture, state colleges of agriculture, U.S. Agricultural Research Service, and U.S. Forest Service. Control projects usually involve several public agencies and private-land owners as well since epidemics have no regard for political subdivisions or property lines.

Attacks by insects and fungi continue after a tree falls. Timber requiring manufacture must be removed from the woods promptly before damage sets in. Wood-destroying fungi perform a service by converting down timber and wastewood into organic matter which in turn becomes humus; this also conserves growing space on the forest floor and removes a fire hazard. Wood in the finished product is still subject to injury from insects and fungi; preservative treatment is necessary if deterioration is to be prevented.

". . . heart rots take a heavy toll in older trees."

Storms

Damage from wind and from sleet is not uncommon in the central region. Occasionally a tornado will devastate timberland. In addition to the timber that is killed, weakened, or deformed, storms often leave a mass of debris which serves as a springboard for attack by insects, disease, and fire. Prompt salvage in logging operations will reduce the danger from such threats and furnish some financial compensation.

Adequate protection is an essential part of the management of a woodland, whether its principal value is for timber, recreation, wildlife, or watershed. Only when woods are well protected can long-range plans for their use be carried out. The enemies of woodlands are many and they are always at work. Any of them may cause serious damage when conditions are exceptionally favorable. Alertness and prompt action must be watchwords in dealing with these destructive agents in order to prevent losses, not only in dollar value, but in enjoyment of the outdoors.

8

TIMBER RESOURCES

In order to manage woodlands for timber production, it is necessary to know

(1) What timber is growing on the land and where it is located? What is the condition of the timber? What species? How many acres of the various kinds of timber? How many board feet, cubic feet, or cords?

(2) What are the site capabilities? What practices should be applied to obtain maximum yields of high-quality timber, and what density of stocking in the various stands will provide this?

(3) How will harvesting proceed: What areas will be cut, in what years, and in what manner? What method of cutting will be used? What species will be favored?

The framework of management is therefore (1) information about the woods, (2) the kinds of treatment needed, and (3) planned harvesting. The remainder of the booklet will discuss these basic elements. It can be readily seen that (2) and (3) cannot be determined without (1), and that obtaining information about the woods is the first step in management.

Inventory and Examination

Data based upon field examination may be obtained for a forest of any size, from a small farm woodland up to extensive industrial or public holdings. Occasionally whole counties, or states, are inventoried. Inventories may be made by federal, state, or local agencies; or by private companies or individuals. The nationwide Forest Survey maintains a continuing inventory of the country's timber resources. This and similar large-scale inventories are carried out in the 4 states by the Central States Forest Experiment Station of the U. S. Forest Service. Cooperating and assisting in each state are the Division of Forestry of the state conservation department, and the state agricultural experiment station. In some

cases, the state extension service and state college of forestry participate also.

Management plans for small woodlands are based upon examination of the tracts, with service (farm) foresters and extension foresters usually playing an important part, providing technical advice and in-the-woods assistance.

Woodland owner examines his tract with an extension forester, who is tagging trees to be cut.

Aerial photographs are used extensively in examinations and inventories. Trained men are able to identify not only forest-cover types, but also broad age-classes and stand densities in the photographs. Certain stands of timber are selected on the photographs, these are found on the ground, and trees in sample plots within the selected stands are measured and tallied. Principles of sampling are applied. Trees in small plots usually 1/5 acre in size are measured, and the data obtained for the sample are then applied to the whole tract. The plots that are measured are either selected at random or mechanically spaced at given intervals in order to preserve the principle of the "chance sample."

A modern mechanical system of computing is coming into wider use in inventorying. It is called mark sensing. Instead of longhand entries on paper forms, followed by arithmetical computa-

tion and summaries of field data, entries are marked directly on cards in the field when the individual trees are measured. The marks are made with a special pencil, the cards are run through business machines sensitized to record the marks, and totals are quickly available.

Forest Types

Land may be classified in a number of ways. One way might be on the basis of cover: forest, grassland, marsh, cropland, water, and urban development. In the same manner that urban development may be segregated into zones — industrial, commercial, residential, and suburban — forest land may be segregated and classified.

The purpose of classifying forest land is to separate out meaningful units for inventory, analysis, and control. For some purposes it is more meaningful, for example, to know whether people "are Brazilians or Japanese or Turks, and if they are Brazilians, whether they are men or women." It is likewise useful to know acreage and volume of the pine type in our central region where pine is valuable and relatively scarce. It is helpful to know how much of the lowland-hardwoods type we have in comparison with an upland type because different species are involved, with corresponding differences in rate of growth and value in the market. If we are to manage a woodland we must know how much old growth we have in relation to young growth, etc.

Segregating parts of the forest into species-groups is a common method of classification. Species-groups are known as *forest types.* The species dominating a stand in either volume or number of stems, depending upon the basis used, determines the name of the type — oak-hickory, for example, or oak-pine, elm-ash-cottonwood, or sugar maple-beech. Types are seldom if ever "pure" but contain species not represented in the type name. Within an area typed sugar maple-beech, the principal species, there might be found some oaks, elms, and ashes, a dozen or more species in all.

Each type is usually further segregated into one or more *condition classes* as to age, diameter, volume, or products to be obtained, or a combination of these. Within the type, stand-size classes such as seedlings and saplings, poletimber, small sawtimber, and large sawtimber might be differentiated; broad age groups — immature, mature, and overmature; or age 0-40 years, 40-80, 80-120, 120

plus, etc. Or the basis of condition classes might be diameters breast high — stands predominantly 0-4 inches, 4-10 inches, 10 plus, etc. A complete designation for a type might be "oak-hickory, overmature;" or "sugar maple-beech, small sawtimber;" or "mixed hardwoods, 0-4 inches."

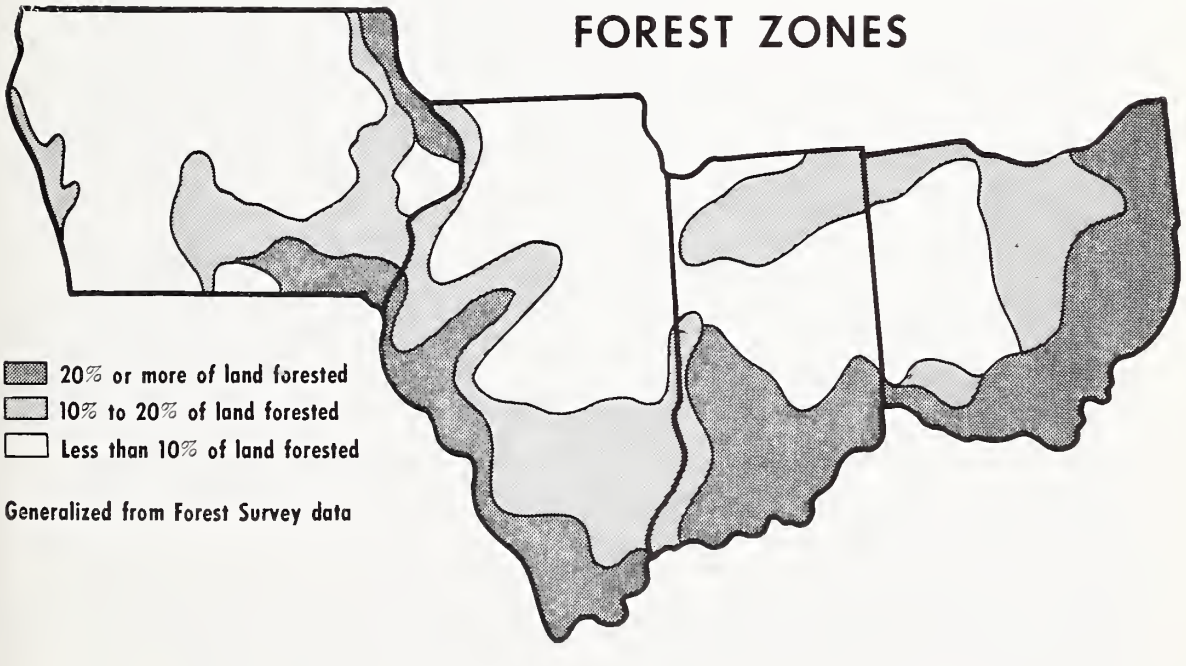
A forest plantation provides an example, simplified and exaggerated, of a forest type. A plantation is an artificial unit, an even-aged forest made up of trees of approximately the same diameter, height, and product class such as fence posts; ordinarily it would contain but one dominating species, too. An all-aged forest composed of many species usually contains more than one type.

Forest Area

The acreage, volume, and ownership data which follow are principally based upon the Forest Survey.

About 13 percent of the central region is forest land, of which nearly 99 percent is *commercial* forest land.[1] Ohio is 20.5 percent forested, Indiana 17.5 percent, Illinois 11 percent, and Iowa 7 percent. Iowa still retains ½ its original forest cover; about ¼ remains in Illinois, ⅕ in Indiana, and ⅕ in Ohio.

[1] Land bearing or capable of bearing usable crops of wood (usually sawtimber), economically available now or prospectively, and not withdrawn from commerical utilization.



In Ohio and Indiana about 50 percent of the commercial forest area is in sawtimber[1] stands, 46 percent in Illinois, and 36 percent in Iowa; the remainder is in the smaller sizes. A part of the commercial forest land is denuded and not stocked with trees — 14 percent in Iowa, 10 percent in Illinois, and around 1 percent in Indiana and Ohio. The preceding figures were drawn from the following table. *All figures for Iowa in the tables are preliminary* as the project in that state has not been completed.

Stand-Size Classes
on commercial forest land, in thousands of acres

STATE	SAWTIMBER	POLES, SAPLINGS, SEEDLINGS	NOT STOCKED	TOTAL
Iowa	950	1,300	350	2,600
Illinois	1,824	1,712	405	3,941
Indiana	2,084	1,937	24	4,045
Ohio	2,679	2,657	60	5,396

The areas of sawtimber stands are at first glance encouraging; but these stands are composed predominantly of low-quality trees and the less-valuable species, an extremely important factor which naturally does not appear in acreage statistics. The data above therefore are largely indicative of production potential rather than present worth.

About 75 species of trees are common enough to be important in the central region out of several times that many found here, and of these about 20 species are produced in quantity sufficient to be a factor in the commercial market. Species are listed in the Appendix on pages 119-121.

Acreages of the major forest types in the 4 states are shown in the following table. To be classified in a certain type, at least 50 percent of the more dominant trees (those with larger crowns) in the stand had to be of the species named in the type, except in the case of oak-pine, where 25 percent pine in the stand was sufficient for classification as oak-pine.

[1] Sawtimber tree: coniferous tree over 9.0 inches d.b.h. or hardwood tree over 11.0 inches d.b.h. Sawtimber stand: stand having minimum net volume of 1,500 board feet per acre in living merchantable trees.

Major Forest Types
on commercial forest land, in thousands of acres

FOREST TYPE	IOWA	ILLINOIS	INDIANA	OHIO	TOTAL
Oak-hickory	1,300	2,461	2,341	3,133	8,490
Elm-ash-cottonwood	1,050	1,337	988	1,334	3,528
Sugar maple-beech	120		419	642	950
Mixed hardwoods	130	143	177	65	2,672
Oak-pine			120	222	342
All types	2,600	3,941	4,045	5,396	15,982

Oak-hickory is seen to be the predominant type in each state. This is an upland type, consisting principally of oaks — white, black, northern red and others, and such hickories as shagbark and bitternut. In Ohio and Indiana, yellow-poplar is often an important component.

Elm-ash-cottonwood is a lowland association and is the second most prominent type in all 4 states. It consists principally of American elm, green ash, and cottonwood; also common in this type are black willow, river birch, red maple, silver maple, and sycamore.

Sugar maple-beech type is found on good soils in hilly country, mostly in northern Ohio and Indiana. Associated species are basswood, white oak, northern red oak, elm, black walnut, and others, including yellow birch in northeast Iowa.

Mixed hardwoods type is a mixture of minor types, upland and lowland, not extensive enough for separate classification. It includes the swamp oak and gum associations, aspen, and others.

Oak-pine is a mixed type of such oaks as white, post, and black; eastern redcedar, shortleaf pine, and Virginia pine. This type is found in the southern part of the region.

The acreage of the above types and their proportions relative to each other will change. Areas in forest may become pastures, cultivated fields, reservoirs, urban developments, airfields, power lines, highways. Areas in pasture and cultivated fields may be allowed to revert to woods or may be planted with trees. Timber types now present may disappear and be replaced by other types of forest. Changes will occur in the process of succession, less stable types giving way to the more permanent types. Intolerant species will be replaced by more tolerant species as the climax stage of forest development is approached. The *principal climax types* in the central states are oak-hickory, elm-ash-cottonwood, and sugar maple-beech.

A bottomland type of cottonwood-silver maple, 37 years old. River lowlands provide some of our heaviest stands. Silt covers the area. High water line (W) is about 4 feet above the ground.

Ownership

Commercial forest land is 95.3 percent privately owned. The remainder is in government ownership — federal, state, and local.

Ownership Classes
of commercial forest land, in thousands of acres

STATE	FEDERAL	STATE	COUNTY	PRIVATE	TOTAL
Iowa	23	13	6	2,558	2,600
Illinois	179	10		752	3,941
Indiana	126	93	2	3,824	4,045
Ohio	88	169	40	5,099	5,396

a. National forests

The federally-owned land shown in the table is almost entirely in national forest. The first national forest in the United States was created in 1891, the beginning of a systematic program to conserve a heritage. There are 149 national forests today in 38 different states and 2 territories. There are also a number of purchase units within which enough land has not yet been acquired for

establishment as national forests. The national forests and purchase units cover some 229 million acres, within which 181 million acres are actually owned by the government. This land belongs to the people of the United States and is administered by the U. S. Forest Service of the Department of Agriculture.

There are 3 national forests in the central region, with the Wayne and Hoosier under joint administration from one headquarters. A part of the Shawnee lies in Missouri. There is a purchase unit of 4,749 acres in southeastern Iowa in an inactive status.

NATIONAL FOREST	LOCATION	SUPERVISORS' HEADQUARTERS	GOVERNMENT-OWNED ACRES	YEAR ESTABLISHED
Shawnee	Illinois & Missouri	Harrisburg, Illinois	210,806 (in Ill.)	1939
Hoosier	Indiana	Bedford, Indiana	114,740	1951
Wayne	Ohio	Bedford, Indiana	102,974	1951

In 1905, Secretary of Agriculture James Wilson charged Chief Forester Pinchot to administer the national forests for "the greatest good of the greatest number in the long run." This has served as a guiding principle to the present day. The words have been widely adopted to express the basic philosophy of conservation although most people are unfamiliar with their original connection with national forests.

Loading pine pulpwood — the first thinnings from a plantation on Shawnee National Forest.

National forests are managed for multiple use. The same general area may be used for growing timber crops; it may serve as a watershed, and as a habitat for wildlife; parts of it may be important for recreational purposes; it may contain mineral deposits or waterpower sites; and open portions may be used as pasture (under fence in the East, unfenced in the West).

In 1954, total receipts of $72 million from all national forests were turned over to the Treasury of the United States. This represented revenue from sales of timber, fees from leases for grazing, water power, summerhome sites, etc. The current operating expenditures on the national forests together with depreciation of roads and other improvements, amounted to nearly $64 million. A "profit" of over $8 million in one year was thereby earned for the people of the United States.

Although not subject to state or local land taxes, national forests return 25 percent of all receipts each year to the states for distribution to the counties in which the national forests are located. By law, this money must be spent by the counties for schools and roads.

Scaling logs to determine their volume in board feet. Knowing average diameter and length of log, board-foot volume can be read direct from the scale stick.

b. State forests

There are state forests in each of the 4 states. They are administered by the state foresters of the various conservation departments under a policy of multiple use.

State Forests

STATE	NUMBER	ACREAGE
Iowa	8	13,400
Illinois	3	10,150
Indiana	13	111,390
Ohio	21	158,390

Some state forests are producing considerable revenue for the state from sales of timber. In Ohio, for example, around 3½ million board feet are harvested annually under good cutting methods. Planting is another important activity on state forests.

c. Private lands

About 94 percent of the privately-owned commercial forest land in Iowa is on farms; 82 percent is on farms in Illinois, 76 percent in Indiana, and 60 percent in Ohio. The farm woodland therefore dominates the forest picture throughout the central region, even though individual holdings average only about 25 acres each. A relatively higher percent of non-farm private land is found in Ohio than in the other 3 states, due to large industrial holdings. The principal industries owning timber in the region are lumber, coal, electric power, and gas companies.

Timber Volume

Commercial forest land in the 4 states supports nearly 41 billion board feet of live sawtimber, net volume.[1] Of this, about 37 billion board feet are in stands of larger-size timber, the remainder being scattered in small-size timber stands. The total net volume of live sawtimber is shown in the following table.

STATE	SAWTIMBER VOLUME (in million board feet)	YEAR OF ESTIMATE
Iowa	5,344	1945
Illinois	10,258	1952
Indiana	11,010	1953
Ohio	14,374	1954
Total	40,986	

[1] Net: sound, usable timber.

Volume per acre in sawtimber stands averages about 5,600 board feet per acre in Iowa and Illinois, 5,300 in Indiana, and 5,400 board feet per acre in Ohio.

Listed in order of importance, the largest volumes of sawtimber are found in the following kinds of trees:

Iowa — white oaks, red oaks, cottonwood, basswood.

Illinois — white oaks, red oaks, hickories, soft maples.

Indiana — red oaks, white oaks, hickories, sugar maples, beech.

Ohio — red oaks, white oaks, hickories, sugar maple, beech, yellow-poplar.

High-quality logs are needed for veneer. These logs from a farm woodland brought a high price. Species are basswood and sugar maple, with some northern red oak and black walnut.

Sawtimber trees are of good size, 60 percent of the volume being in trees at least 15 inches d.b.h. Unfortunately, the volume in these large trees is only about 20 percent high-quality material. Many are deformed, knotty, or infected with decay. Wood-using industries have declined as supplies have shrunk. High-quality trees are becoming more scattered as they are sought out and cut, and costs of logging them are rising accordingly.

The new growth being accumulated each year is mostly on timber of low quality. Since 80 to 85 percent of the future supply must be obtained from low-quality timber, any steps that can be

taken to remove poor trees will improve the stands and upgrade future supplies. Unfortunately, the trend is in reverse, with industries ranging farther afield in attempts to find sound timber of desirable species in large diameters. As a result, the volume *cut* of high-quality timber in the central region exceeds volume *growth* of high-quality timber by 40 to 50 percent.

Loading black walnut — one of the most valuable species. These logs were marketed through a woodland owners' cooperative association.

The central states have a great timber-producing potential. There is a large area available, and conditions are favorable for rapid growth of some of the best species of timber trees. Existing woodlands are mostly in poor condition for good growth because of degraded timber, fire, grazing, and lack of market outlets for the small-sized and poor-quality hardwood timber that characterizes the region. The farmer is in a key position with regard to timber-growing because, as a class, he owns a large share of the total wooded area.

9

FORESTRY PRACTICES

Common methods of treating forest lands are by planting, stand improvement, and harvesting.

Forest Planting

In the central region, vegetation of some kind soon reclaims abandoned cropland or pasture, and land bared by fire or road construction. Land strip mined for coal usually becomes covered very slowly. The results of natural invasion, however, are seldom satisfactory. Development of a stand of desirable commercial species is dependent upon the more mellow site conditions created by the lower succession stages, but mellowing is a slow process. Frequently, too, seed-sources of desirable species are not near enough at hand to supply the beginnings of a new stand. Planting is therefore desirable in many instances.

To illustrate why man often plants trees in order to shortcut succession, it is only necessary to consider the number of years required for vegetation to develop through the natural stages typical of wornout, eroded fields. Stages in succession would normally be:

bared soil
lichens and poverty grass
lambsquarter and ragweed
yarrow, fleabane, broomsedge
sumac and sassafras
oak and hickory.

Twenty years might be required to establish the woodland of oak and hickory, the trees of which would, in all likelihood, be of poor form and quality. Planting can shorten the time required to establish a forest and improve its quality by starting immediately with the tree-seedling stage, probably using coniferous species since they thrive better on open sites having depleted soil. Planting gives rise in effect to an artificial subclimax type of species different from the

original woodland. On good sites when seed-sources are present, hardwoods might become naturally established under the planted conifers in a year or two.

A great deal of forest planting has been done in the central region, as shown in the following table.

STATE	ACRES PLANTED TO 1955	ACRES PLANTED 1954 ONLY
Iowa	271,000	549
Illinois	115,000	9,994
Indiana	112,000	9,857
Ohio	179,000	17,356

Most of the planting was done by private owners on farms, although there was considerable industrial planting in Ohio; state and federal planting accounted for nearly all of the remainder. At the present rate of planting, the total planting job as conservatively estimated by foresters would require 35 years to complete in Ohio, 164 years in Indiana, 374 years in Illinois, and 1,445 years in Iowa. Serious as this appears, the real situation may be even worse because voluntary growth of weed trees is taking over plantable sites at a rapid rate and, once grown, require prohibitively large outlays of money for removal. Thousands of acres of land that should be planted will therefore never produce anything but woodlands valueless from a timber standpoint.

The principal species planted are conifers — mostly shortleaf pine, white pine, and red pine, with smaller amounts of jack pine, pitch pine, loblolly pine, Virginia pine, and eastern redcedar. Of every 10 trees planted, possibly 9 are conifers, one a hardwood. Conifers are better adapted to the wornout and eroded soils upon which most of the planting is done, they grow faster, and they are more in demand for construction purposes. Among the hardwoods, black locust is a leading species because it grows rapidly on good soil and quickly improves the site. Yellow-poplar, sycamore, cottonwood, black walnut, white ash, and green ash are also commonly planted on good sites.

Annual growth of 2 feet in height is common for black locust. It is particularly useful as a "nurse" crop for more valuable tolerant species planted in mixture with it, the locust establishing itself quickly and shooting up to form a protective overstory. Locust also adds nitrogen compounds that are necessary for good growth of hardwoods and deficient in the type of soils usually planted.

Spacings of from 6 to 8 feet are most satisfactory except in special cases. Planting 6 x 6 feet requires 1,210 seedlings per acre; 8 x 8 feet requires 680; and 6 x 8 feet requires 910 seedlings per acre.

Spring planting, beginning as early as March 15 in the southern part of the region, and extending to as late as May 1 in the north, seems to give better results than fall planting, although fall plantings show good survival when made in thick cover such as broomsedge. One man using a hand tool can plant from 300 to 800 trees per day, depending upon the method and type of ground, while tree-planting machines using 2 or 3 men handle about 7,500 trees per day.

This tool is known as an increment ("growth") borer. It is twisted into the tree, and when the extractor is pulled out, it reveals a core showing growth rings.

In all 4 states, strip mining for coal has destroyed vegetative cover in the process of removing the "overburden" of surface soils to expose productive seams. The resulting *spoil banks* left after mining are frequently of abnormal chemical reaction, either acidic (from the oxidation of the sulphur-bearing rocks or pyrites) or neutral or alkaline (from the decomposition of limestone.)

Spoil banks nearly always present difficult planting sites. The soil has changed in structure and in chemical reaction. The land is exposed to sun, heat, cold, and wind; topography is frequently steep because of the man-made hills. Foresters therefore usually make soil tests and carefully select species to be planted. Among those surviving well on spoil banks under certain conditions are black locust, cottonwood, green ash, white ash, black walnut, and the pines.

Indiana and Ohio have laws requiring the reforestation of strip-mined land. Once trees are established, the hills often provide attractive relief in otherwise gentle topography. They become areas useful for wildlife and recreation in 10 years or so, particularly when lakes form in the depressions.

The barren hills resulting from strip mining for coal were planted with black locust . . . "They become areas useful for wildlife and recreation in 10 years or so, particularly when lakes form in the depressions." Wayne National Forest.

Stand Improvement

The ultimate value of a stand can be increased manyfold by assisting the normal growth processes. Common methods of improving stands are by pruning, thinning, release, and reinforcement planting. The improvements most needed in the region are the elimination of cull trees and the cutting of low-quality trees that have a market. Much of this kind of work can be done as thinning and release, and during the course of logging operations.

Improvement work may be done in either natural stands or in plantations.

Pruning consists in trimming the lower branches close to the trunk. This is usually done on pole-sized trees from ground level to a height of 17 feet, thus eventually producing knot-free lumber in a 16-foot log, the length most in demand. The bottom or butt log yields the clearest lumber and is the most valuable. A special saw mounted on an ax handle or a pole is used, or regular saws may be used by men working on ladders. Pruning can only be justified when the work is done upon valuable species which do not clean themselves well naturally, such as the pines and black walnut in plantations, and only on 50-100 carefully selected crop trees per acre.

Plantation of red pine and white pine pruned to a height of 8 feet.

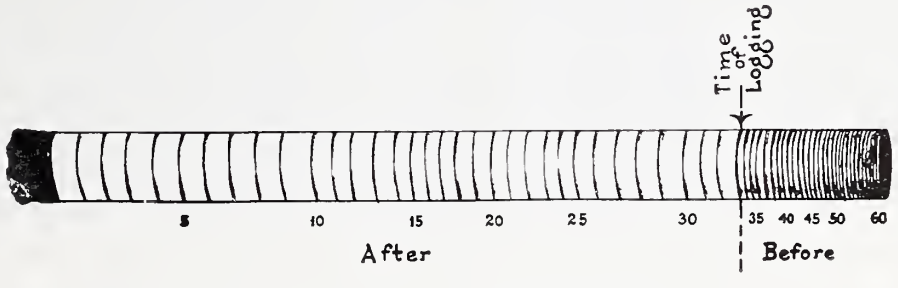
Thinning provides additional growing space and thus increases the rate of growth on selected crop trees; it also removes trees of undesirable species, form, or condition. If there is a market for small material, thinnings will yield cash returns at least sufficient to pay the cost of the operation, and often a profit besides. Thinning is seldom needed in other than young, even-aged stands. It is common practice in plantations of conifers.

One rule-of-thumb recommended for determining proper spacing in thinning is to determine distance between trees by multiplying 1.75 times the average d.b.h. of the stand. In a plantation

of 6-inch trees for example, spacing should be 6 x 1.75 or 10.5 feet. Frequent light thinnings are generally preferable in any type of stand to more infrequent heavier thinnings.

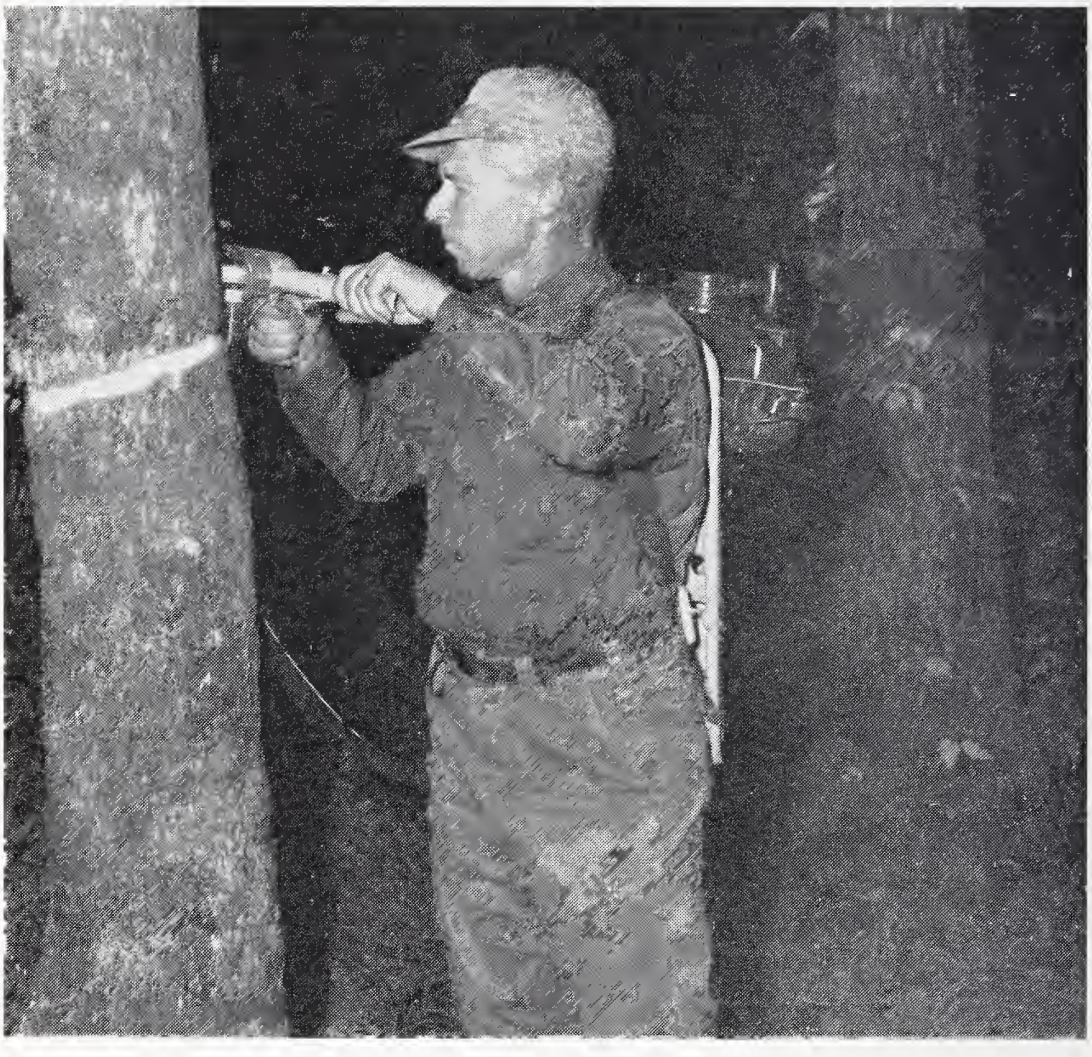
Release consists of removing inferior vegetation which overtops, or will overtop, those selected to be the crop or harvest trees. Killing cull trees and cutting low-quality merchantable trees provide effective release. Unwanted trees are treated by cutting, girdling, or applying chemicals. For good results, expected response of the harvest trees to release must be known by the person who directs the work. Some species exhibit a different degree of tolerance at various stages of growth, and some species grow faster than others when more sunlight is made available. High-value species showing good response which should be favored in selection for release include white oak, northern red oak, ash, basswood, yellow-poplar, black walnut, and the pines. Another form of release frequently needed is the removal of vines which smother hardwoods, rob them of nutrients and water, and cause breakage as a result of accumulated ice and snow.

An important benefit derived from thinning or release is the stepped-up volume growth obtained on the remaining trees. If growing conditions in a dense stand are improved by removing some of the trees, the total annual growth on the remaining stand may be no greater, but this volume will be concentrated on fewer and better trees. The growth on individual trees will therefore be greater than it was before. This is the principle behind the early selection of crop trees, favoring them through to maturity.



Core from increment borer shows increase in growth rate in a tree 60 years old following release by logging of its neighbors. It grew slowly for 27 years before logging took place; then it grew rapidly for 33 years.

Reinforcement planting refers to the planting of small openings in woodlands to utilize growing space more fully and to improve composition of stands by adding desirable species. Reinforcement planting is known to foresters in some localities by the descriptive term "sweetening." It is simply "spot planting" as contrasted with the more familiar "block planting" in large units. Reinforcement planting is a useful practice in stands from which livestock have been excluded following heavy pasturing and killing of young growth.



Girdling a tree to deaden it, using special cutting tool.

Forestry Laws

About 80 years are required in the central region for a tree to grow to a d.b.h. of 18 to 22 inches and yield first-grade sawlogs. Payment of full property taxes every year throughout this period is so burdensome that the woodland owner might well consider practicing forestry in order to get the fullest possible return on his investment. Few small owners apply this kind of reasoning,

however, and must be encouraged to grow timber as a crop through some form of tax equalization. Iowa, Indiana, and Ohio have such laws and they are proving helpful.

In Iowa, an owner may apply for a special low assessment at $4 per acre of woodlands 2 acres or more in area. In Indiana, owners may apply for assessment at $1 per acre of timberland 3 acres or more in area. Ohio timberland owners may apply for a 50 percent reduction below the local tax rate. Figures available from Iowa show typical tax valuations for woodlands to be between $12 and $27 per acre, with $15 about average. When classified as a "forest reservation" under the Iowa law, the valuation is only $4 per acre, a strong inducement to keep livestock out as required, to manage woodlands for continuous yields, and to plant new woodlands.

Certain requirements are set up in the 3 states regarding the degree of stocking on the land applied for to insure that it is in truth forest land that is to receive the beneficial low rates. The land is required to be kept fully stocked, and closed to livestock grazing. Applications for lower assessments are made to the state forester.

That the tax laws can be a practical incentive for getting forestry applied on the land is indicated by reports for 1954 showing 1,455 owners in Ohio registered under the "forest tax" program, representing 91,998 acres; in Iowa 3,435 owners with a total of 75,174 acres registered under the "forest reservation" program; and in Indiana 2,685 owners representing 169,890 acres registered under the "classified forest" program. Different names are used for the various programs, but the objectives of tax relief are the same.

Service to Private Owners

Farmers are by far the most important timber owners as a class, both regionally and nationally. The net effect of any one individual's cutting practices on the quantity and quality of future timber supplies is negligible, but the cumulative effect of thousands is extremely important.

The small-tract owner often considers woodland as a part of his pasture, a source of posts and fuel, or a windbreak. He may appreciate the pleasant environment it offers and recognize its worth to wildlife. But chances are he does not know how to keep

his woodland productive or how it should be treated to produce maximum returns. He has little conception of its value in dollars when someone offers to buy stumpage.[1] Few woodland owners have a basis for determining whether a stand is ready for cutting, and if it is, how it should be cut to insure a future crop.

In a joint effort to assist woodland owners, the forestry divisions of the state conservation departments, and U. S. Department of Agriculture cooperate in a program of education and in-the-woods service.

State extension foresters have headquarters at Iowa State College, University of Illinois, Purdue University, and Ohio Agricultural Experiment Station. They are jointly employed by the colleges and the Extension Service of the U. S. Department of Agriculture, which shares salaries and supervision of their programs. Extension foresters work through the local county agricultural agents to provide detailed instruction in woodland management at outdoor meetings attended by groups of farmers. Demonstrations are held illustrating good cutting practices, thinning, girdling and poisoning, planting, scaling, marketing techniques, fire-prevention and control methods, wood-preservative treatments, and proper use of wood products in farm construction. Extension foresters also work closely with 4-H Club leaders to extend forestry knowledge.

[1] Stumpage: uncut timber "on the stump."

Learning firsthand how to make farm woodlands pay.

Future Farmers of America and the vocational agriculture programs of the U. S. Office of Education both make important contributions to woodland management.

Extension forestry and education in technical forestry are centered at the land-grant colleges — Iowa State College, Purdue University, University of Illinois, and Ohio State University. Iowa State and Purdue offer professional forestry; and Illinois, Southern Illinois, and Ohio State offer preforestry instruction. Degrees in conservation are offered at Purdue University and University of Indiana.

The small-woodland owner is sure to encounter problems as he attempts to carry out what he learns. Here specific in-the-woods help may be needed in actual cruising of timber to determine volume, or in marking selectively so that a future crop is assured as well as immediate cash returns. Advice on marketing is often needed also. *Service foresters* (often known as "farm," "local," or "county" foresters) provide this kind of direct on-the-ground assistance. They are employed by the state forester, with from 12 to 34 percent (in the central states) of their salaries and expenses paid from federal funds under the Cooperative Forest Management Act as administered by the U. S. Forest Service. Through this program in 1954 there were 5 service foresters employed in Iowa, 3 in Indiana, 6 in Illinois, and 13 in Ohio.

Woodland owner and service forester debate whether this tree should have been cut. It was sound, still growing, although slowly, and would have produced good interest on the stump for the next cut 10 years later.

Industrial Forestry

That wood-using industries are applying more technical forestry on their holdings is indicated by the employment of about 6,000 professional foresters in private foresrty across the nation, over twice as many as there were 10 years ago. Business services are also available to industry by consulting foresters who operate in private practice. Of these Iowa has one, Illinois 2, Indiana 6, and Ohio has 3. About 2,000 acres have been planted by forest industries in the central region.

A number of private and industrial organizations carry on forestry activities designed to help the timberland owner. Among them are the American Walnut Manufacturers Association, the Fine Hardwoods Association, the forestry committee of the American Bankers Association, and the Railway Tie Association.

The *Tree Farm* and *Keep America Green* programs of American Forest Products Industries, Inc., in cooperation with state foresters have stimulated reforestation, fire protection, and better cutting practices by forest industries and smaller private owners. Ohio takes part in the tree-farm program and in 1954 had 303 tree farms representing 81,706 acres.

Several companies in the region have made a good start in applying forest management upon their lands, notably the Baker Wood Preserving Company of McArthur in southern Ohio, and the Amana Colony in eastern Iowa. Each state has examples of farm woods under management, but many thousands of small-tract owners still need advice and assistance in the management of their woodland properties.

Several professional groups exert influence for better forest management in the central area. National organizations include the American Forestry Association, with membership open to the public, and the Society of American Foresters, for professionals. The Ohio Forestry Association and the Illinois Technical Forestry Association provide leadership in their respective states.

Research

Research is necessary to provide answers to problems of utilizing low-grade timber, marketing farm timber, and growing better timber, faster. When such answers are made available to those who are in a position to apply them, research becomes education.

Some of the forest industries carry on research in the fields of timber harvesting, wood use, and marketing. The principal studies in forest management and forest economics are the work of the public agencies — state divisions of forestry, state universities or colleges, and U. S. Forest Service.

The region's most extensive research program is that of the Central States Forest Experiment Station of the U. S. Forest Service. Headquarters are in Columbus, Ohio. Information on local forest types is obtained through field research centers in headquarters furnished free of charge by various universities. The field organization of the Station is outlined below.

Central States Forest Experiment Station
U.S. Forest Service
Headquarters in Columbus, Ohio

FIELD RESEARCH CENTER	OFFICE AND LABORATORY FACILITIES SUPPLIED BY	LOCATION OF EXPERIMENTAL FOREST
Ames, Iowa	Iowa State College	Amana, Iowa
Carbondale, Illinois	Southern Illinois Univ.	Elizabethtown, Illinois
Athens, Ohio	Ohio University	McArthur, Ohio
Columbia, Missouri	University of Missouri	Salem, Missouri

Research study in a shortleaf pine plantation thinned to release the harvest trees. Work conducted by a state agricultural experiment station.

Since a problem of high priority in the region is the removal of low-grade trees, some use must be found for them which will make removal profitable. A wood-processing plant is therefore being set up at Carbondale research center in cooperation with Southern Illinois University. The plant will be devoted to developing methods for using material which at present has a limited market.

The nation's principal headquarters for investigations in the properties and uses of wood is the Forest Products Laboratory of the U. S. Forest Service maintained at Madison, Wisconsin in cooperation with the University. Studies are carried on in the fields of wood preservation, diseases of wood, pulp and paper manufacture, wood waste, wood chemistry, shipping containers, timber physics and mechanics, wood structure, sawmill methods, and seasoning.

Research in various branches of forestry and forest products is being carried forward continuously in each of the 4 states, by state universities and colleges, state agricultural experiment stations, and some industrial concerns. The Battelle Institute of Columbus, Ohio has recently embarked on a program to create opportunities for an expansion of research facilities for the forest-products and wood-using industries.

While the timber crop is growing, it is often possible to apply treatment which will not only greatly increase the value of the stand, but yield cash returns. Most of our central woodlands are in need of girdling or cutting in order to kill undesirable trees, and harvest cutting to remove low-quality trees that are merchantable. A large area of land should be planted to trees of desirable species in order to get it producing a useful crop instead of weed trees and brush. Help and guidance are available to farmers in the protection and management of their woods. Public support of forestry measures will be slow until education brings a realization of the many benefits that can be expected from highly-productive woodlands.

10

TIMBER HARVEST

Continuous Production

Sustained yields are dependent upon having trees continuously available for market. An adequate number of trees must always be growing into the merchantable-size classes either to be immediately harvested or to be left to increase in volume for a later cut.[1]

A properly-stocked young stand will consist of many more stems per acre than a properly-stocked older stand. Competition and natural mortality provide for the tree's increasing needs for sunlight and moisture as it grows larger by killing some of its neighbors. Thinnings also help meet these needs by reducing the number of stems per acre. Assuming a case in which 20,000 hardwood seedlings start life on one acre, perhaps only 2,000 saplings will be alive at 10 years, 300 trees at 50 years, and 100 at 150 years.

Under ideal conditions there is an optimum number of stems for each age and type of forest. One guide, for example, suggests the following stocking as desirable for mixed oaks in southern Illinois:

DIAMETER GROUP (inches d.b.h.)	NUMBER OF TREES PER ACRE
5 — 10	80 — 90
11 — 17	46 — 50
18 and over	2 — 5
	Total 128 — 145 trees per acre at least 5 inches d.b.h.

[1] The period which elapses between repeated cuttings over the same general area is called the *cutting cycle;* under crude management it might be 40 or 50 years, under intensive management, 5 years or less.

Most stands in our region are poorly stocked. Young growth is commonly too dense or too sparse; older age-classes are usually deficient in number of stems per acre.

When age-classes are not distributed equally, it is difficult to maintain a continuous harvest. It may be necessary to defer cutting of some mature timber while young stands are growing to merchantable size. Conversely, some cutting may be necessary in stands which have not reached maturity but which will yield merchantable products. Employment and community stability may be disrupted by fluctuations in annual cut. Unless new uses can be found for the kind of timber available in the predominating age-classes, or new processes developed which will make harvest of this timber feasible, employment dislocations will result. Once under good management, woodlands exert a stabilizing influence in communities.

A stand 6 years after a heavy improvement cut which removed all merchantable trees not judged to be good growing stock. This included mature, overmature, sound low-quality, and defective low-quality trees. All culls (merchantable trees, not growing stock) were girdled. Most of these fell. The cut on this area removed about half the volume. Another cut will be possible within a few years.

A. Assuming the *objective of management is to attain sustained yield of sawtimber,*

1. *If large trees predominate,* the cutting of large timber may be extended over a period of years sufficient for the new harvest-

trees to mature. This will provide a continuing operation. However, the owner may prefer to remove the mature and overmature timber all at once; or the stand may be old and deteriorating, requiring prompt removal. In these cases, there will be a long interval before the next cut can be made.

2. *If young trees predominate,* it may be possible to harvest small amounts of pulpwood, posts, or mine timbers while the harvest-trees are reaching sawtimber size. If there is not enough of this small material to sustain cutting operations, or if there is no market for it, cutting will of necessity have to be much reduced or stopped entirely for a period of years.

B. Assuming the *desired product is small material,* such as pulpwood, it is possible to operate on a sustained-yield basis entirely within small-diameter classes. This is accomplished by cutting the tree soon after it reaches merchantable diameter, either selecting individual trees, or as is more often the case, selecting whole stands and clearcutting as a series of operations in even-aged stands. For continuous operation, new stands must always be growing into the harvest class.

Stability of timber operation in this region is hampered by the predominance of low-grade material and species for which there is little demand. While larger timber of preferred species finds a ready market as sawlogs or veneer bolts, smaller timber of poor species usually cannot be sold. Thinnings from coniferous plantations can usually be marketed since pulp manufacturers prefer the long, soft fibers of the conifers. Although certain pulping processes make use of hardwoods, our thousands of acres of low-value hardwoods will find a ready market only when more economical methods capable of transforming them into good-quality pulp are more highly perfected. The fuelwood market is so limited as to be of little consequence in disposing of small material.

One of the principal goals of management must be to find ways to improve the quality of our timber; this to a large extent depends upon the development of markets for timber now unwanted, and the *willingness of owners to go into their woodlands and cut, girdle, or poison cull trees.*

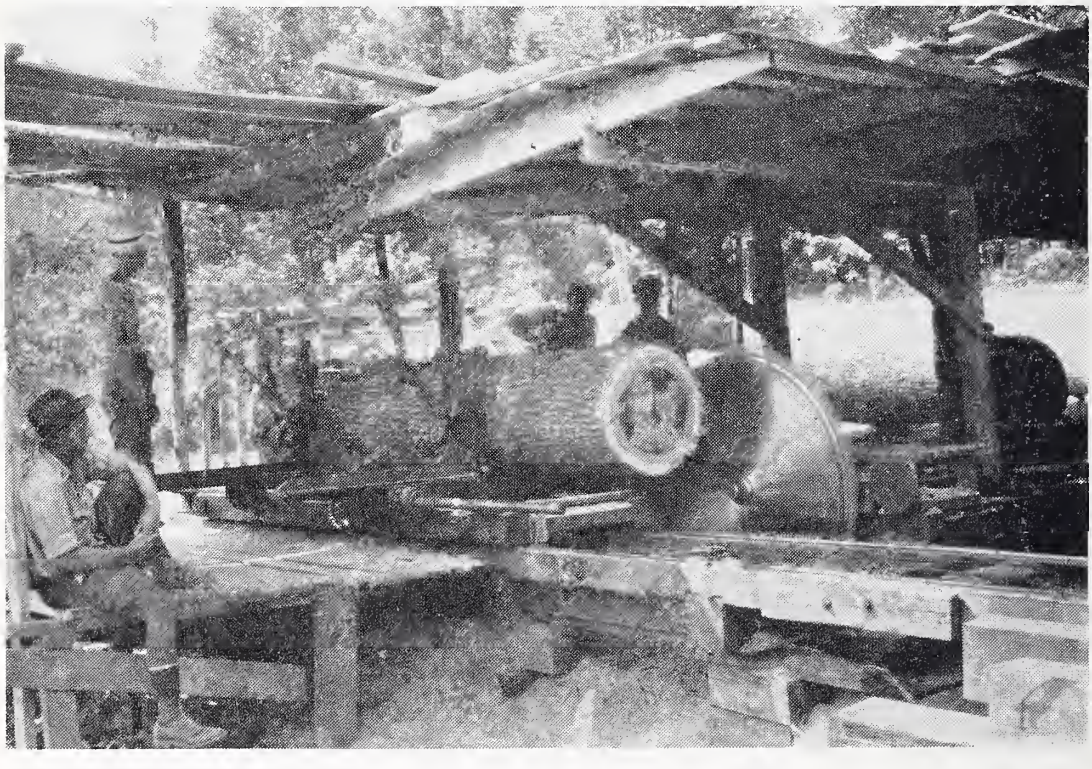
Cutting Methods

Under good forestry practice, cutting becomes a tool for accomplishing 3 results simultaneously:

1. Harvesting merchantable timber
2. Obtaining reproduction of a new crop of desirable species
3. Improving growth rate and species composition.

The harvest of trees, however carelessly done, can be accomplished by anyone equipped with ax and saw. Objectives (2) and (3), however, indicate points of deviation between good forestry and careless logging.

1. *In harvesting merchantable timber* under forestry methods, there must be a way of indicating to the cutters which trees are to be felled and which are to be left standing. Cutting to a "diameter limit" is occasionally done; instructions are simply issued to cut all merchantable trees above 16 inches d.b.h. — or whatever the limit is. The most obvious weakness in this from a forestry standpoint is that some trees smaller than the diameter limit should be cut while others, above the diameter limit, should be left standing.



A small sawmill. Log to be sawed moves on log carriage which is pulled by cable and travels on tracks (lower right). Block setter (standing, left) turns log using levers, upon signal from sawyer (wearing cap, right center). Logs are rolled to saw from log deck (right) by deckman (left of sawyer).

In selective harvesting, individual trees must be designated in some way for cutting or deadening. Foresters therefore work through the stand, looking over the trees carefully and marking with one symbol those that are to be cut and with a different symbol those that are to be deadened. A paint gun is commonly used to mark the tree, applying light-colored paint at eye level or above so that it can be seen readily by the cutters when the logging operation starts. A mark is usually placed near ground level also as a check after the tree is down; in case there is no paint mark on the stump, the cutter can be held responsible for felling an undesignated tree.

During logging, stumps should be cut low and usable products should be obtained from the fallen tree to the fullest extent possible. Care should be exercised in felling and in dragging the material out of the woods (skidding) so that standing trees, particularly young growth, are not injured.

2. *To obtain reproduction of desirable species,* cutting must first of all provide holes in the crown canopy, or so reduce overall density that the better species, which are light-demanding, will grow. Cutting should also provide for leaving parent trees nearby, and for a favorable seedbed.

The person selecting the trees to be cut and to be left must have knowledge of the regenerative characteristics of the various species. Other factors entering into choice are weight and structure of the seed (how far may it be carried by the wind?), capacity of the seed to germinate, and kind of soil required for germination. Tolerance characteristics of the young trees which will be established are important in deciding size of openings to be created.

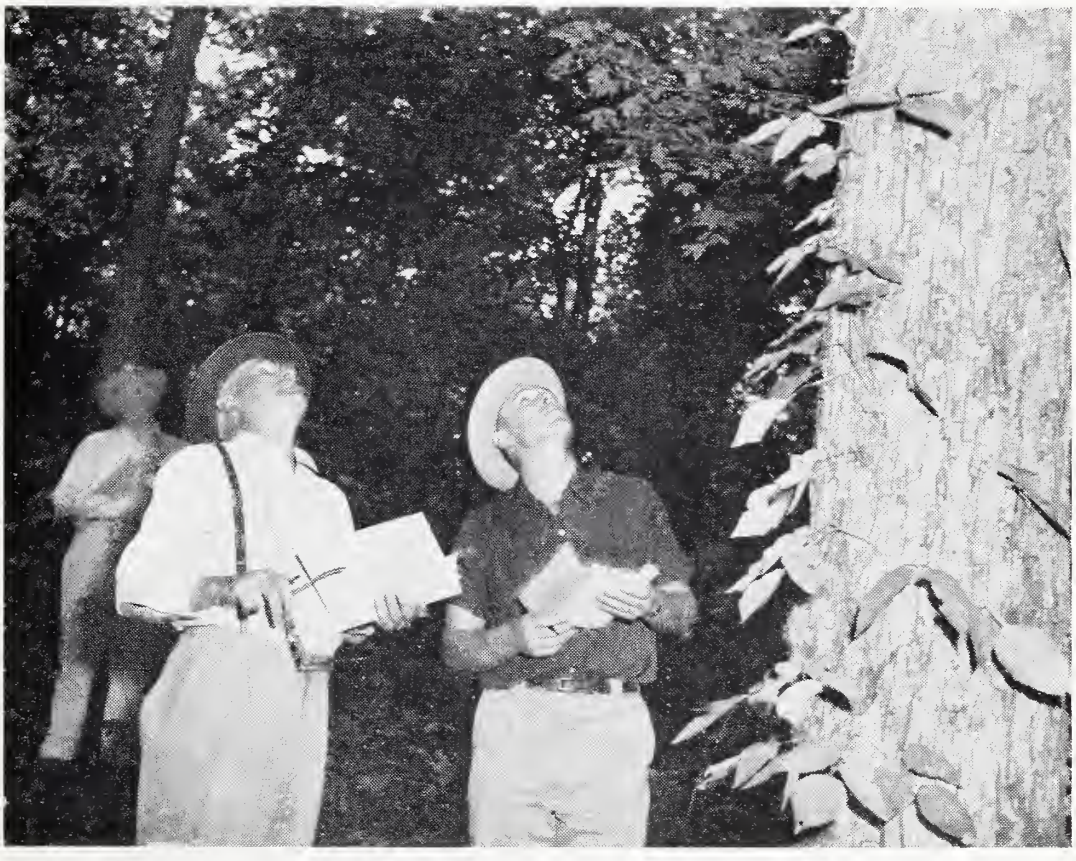
Since most of our species are quite intolerant, some method of partial cutting must be employed which will create sizable openings. For this purpose, one of two common systems is usually employed: (1) *Group-selection in uneven-aged stands* where the oldest trees are removed by clearcutting patches or small groups. This method maintains the uneven-aged form of forest, ordinarily a desirable characteristic in central woodlands since it provides protection of the site and provides a continuous supply of trees of all sizes that may be needed. (2) Some form of *"shelterwood" cutting in even-aged stands* where practically all of the trees are in the older age-classes and are removed in a series of several cuttings within a period of 10 or 15 years. The new forest will be essentially even-aged. While the shelterwood method insures

reproduction and protects the site, if properly applied, it does not yield a continuous supply of timber of all ages.

3. In order to achieve the objective of *improving growth rate and species composition,* cutting practices and girdling must be so directed that the proportions and growing space of valuable species and the best individual trees are increased at the expense of weed species and culls. Species to be favored in treatment include yellow-poplar, white oak, northern red oak, black oak, conifers, cottonwood, black walnut, black cherry, basswood, and white ash. Species ordinarily discriminated against include the hickories, blackgum, beech, scarlet oak, blackjack oak, and sassafras. Sugar maple is favored in the northern part of the region, discriminated against in the south where it is subject to rot. Cutting should be directed upon trees that have reached maturity; trees injured by disease or insect attack; crooked trees; those with low forks, large branches, and widespread crowns; trees with severe fire scars; those damaged or broken in the top; and trees leaning badly. After undesirable trees are killed or logged off, more sunlight and moisture are available for the desirable trees that remain. By applying careful selection in cutting, the whole character of the stand, present and future, can be influenced for the better.

The group-selection system of partial cutting, in which trees are removed in groups or patches. This method permits considerable open sunlight to reach the ground.

The forest is complex, particularly the uneven-aged, mixed forest. Cutting not guided by a knowledge of forestry therefore seldom provides highly productive growing conditions and, when unsupervised, falls short of the most rudimentary forestry goals, particularly when dedicated to getting the highest possible profit off the land in the quickest possible time. Proper designation of "cut," "leave," and "kill" trees is an art. Even with technical supervision the 3 objectives outlined may not be fully realized in harvesting.



Judging trees for "cut" and "leave" on an experimental forest.

Pine Plantations

Pine plantations should be under intensive management with cuttings closely controlled. Thinning may be done at from about age 15 in southern Indiana and Illinois to age 25 farther north, at an average diameter of about 6 inches. Additional light thinnings every 5 to 10 years should be made until a spacing of around 16 to 18 feet is reached at 12 inches d.b.h., after which the spacing would be increased by harvest cuttings.

A pine plantation is even-aged at the outset and will continue so for many years. Eventually, however, as young pines become established from the parent stock and hardwoods develop in the shade of the pines from transported seeds, the stand begins to

develop an understory and assume an uneven-aged aspect. As shade increases and the layer of litter and humus deepens, the site becomes more congenial for hardwoods; they grow rapidly and finally dominate. Stand-improvement practices and cutting methods in such cases must be adapted to the changing requirements as the stand develops.

Farm Woodlands

An examination of nearly any farm woods will show 4 classes of trees which can be used as the basis for management: culls, harvest stock, reserve stock, and good-growing stock. *Culls* should all be removed leaving an occasional den tree for wildlife purposes. The *harvest stock* includes mature trees and those with a declining growth rate. They should also be cut. *Reserve stock* is made up of trees approaching maturity but still adding growth each year. They are moving into the harvest class, and may be cut within 10 years or so. The *good-growing stock* consists of thrifty and fast-growing trees of any age, the foundation of future harvests. These trees should be left to increase in volume and value.

Work in a farm woods can be done in the winter and the products harvested can be used on the farm or sold. Within 5 years, deteriorated woodlands will show the beginnings of recovery if management practices are set in motion. Many woodlands yield only fuelwood, yet have possibilities for high-value use. In Ohio, for example, the average annual value of products sold from woodlands is about 82 cents per acre. One farmer, however, recently sold enough products from his 30-acre woodland to bring a net return of $54 per acre, and since he is managing his land in such a way that he can make a similar cutting in 8 or 10 years, his annual net return is over $5 per acre per year, more than 6 times the annual profit of 82 cents received by the average Ohio farmer from woodland.

Steps in managing a farm woodland might well include:

1. A decision as to whether the ultimate use of the area is to be timber production.
2. If timber is the goal, close the woodland to grazing and keep out fire.
3. Clean out weed trees and culls by girdling or felling.
4. If the stand consists of dense pole-size timber, thin it out.
5. Plant large openings where natural reproduction does not appear likely to occur.

6. Plan the harvest cuts on the basis of a short cutting cycle (2-8 years in upland types).
7. Obtain technical assistance whenever needed.
8. Expend effort in marketing the timber products to the best advantage.
9. When harvesting timber, use the farm's available labor and equipment.

Logs equivalent to one year's growth in a 24-acre farm woodland were selectively cut, demonstrating that good forestry can be made to pay in cash.

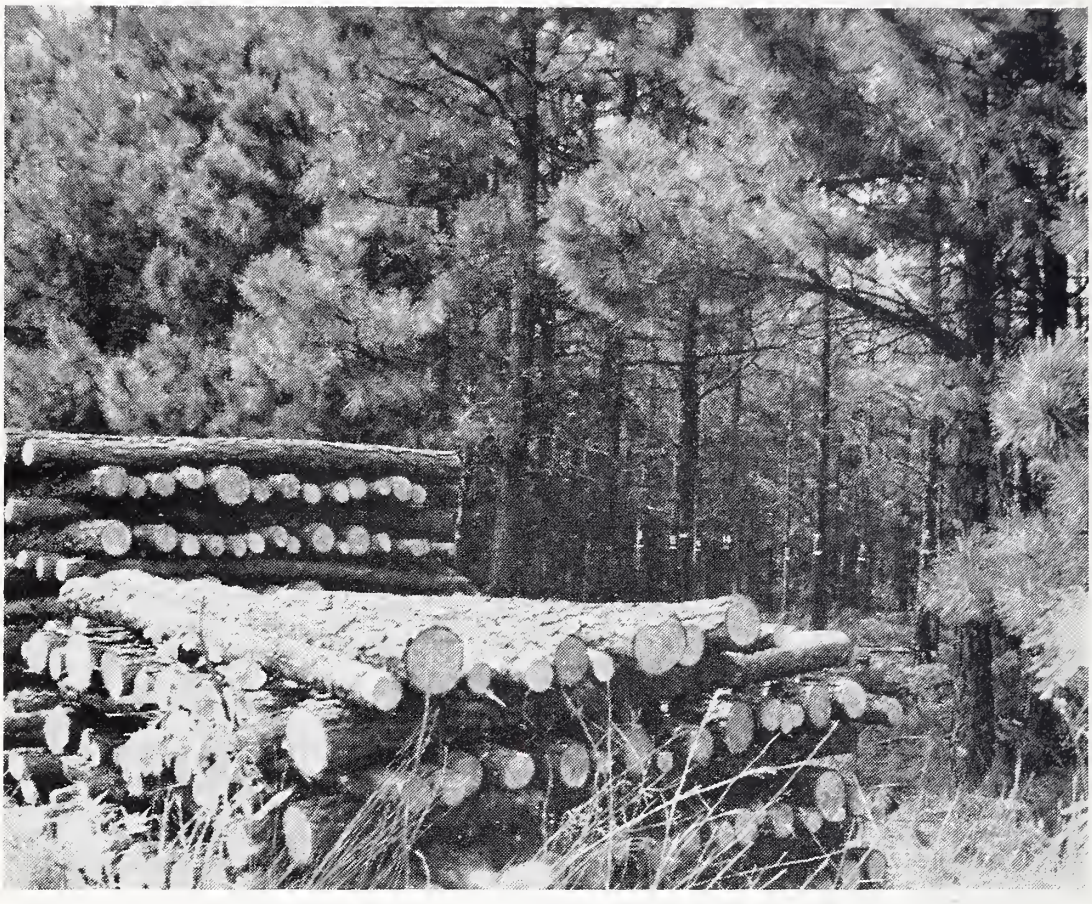
Forestry Goals

Most people living in the central region probably think of their local resources in terms of manufacturing if they live in a city, or in terms of corn, hogs, and cattle if they live in a rural community. Yet our forests are important, as we have seen, providing a variety of benefits. These benefits can be greatly increased if we can improve and extend our woodlands. One acre in every 8 is in woods, and land is too valuable to permit continued deterioration in forests already overburdened with weed trees and culls.

The region provides a tremendous local market for its own forest products. For example: Illinois and Ohio are among the first 6 states in volume of wood used in all types of manufacturing; Indiana and Illinois are top states in use of wood for furniture;

Iowa uses about 212 million board feet of lumber a year, of which only about ¼ is produced within the state.

The unfavorable ratio between use and production is partly due to heavy importations of coniferous timber not available from local woodlands, one reason why foresters want to increase the acreage and volume of conifers.



Pulpwood cut from thinnings in pine plantation 14 years old. Remaining trees numbered to study stepped-up growth rate (background).

Total growth in the region is annually in excess of drain (use plus losses plus waste.) The ratio in favor of growth, however, is due to large volume growth on the smaller trees. Considered separately, large sawtimber shows a less favorable relationship, with drain in excess of growth. The balance is still more unfavorable when only high-quality sawtimber is considered, since drain exceeds growth by nearly 50 per cent in this kind of material.

The pressure upon high-quality timber in the larger sizes is cause for concern. White ash is sought for handles, black walnut for veneer, and white oak for veneer and stave bolts. Yet only about 15 to 20 percent of the net annual growth is on high-quality trees of such desired species.

As the demand for high-quality material is expected to continue, it is clear that more low-quality woodlands must be brought into the high-quality class by various means. This will take considerable effort, ingenuity, and time. There is every indication that good logs are going to be more and more difficult to find, and probably more expensive, in the years immediately ahead.

Success in maintaining at their present economic level those communities and industries largely dependent upon the woods, hinges upon finding uses for low-grade logs and small timber, and discovering low-cost processing methods. Industries equipped to manufacture only one type of product, such as veneer, will not be helped of course by the development of a new kind of salable product. Such industries may have to import timber from new sources in order to survive. Woods workers will be able to continue in their jobs as long as there is a demand for timber, regardless of whether it is used for existing industries or those of a new type. However, should no new industry arise to replace the old, a dislocation in employment would result.

In order to give the people of the central region more raw material close at hand for manufacture, to strengthen the national economy by strengthening the local economy, and to provide residents with a pleasanter place to live, a broad program of improvement for forests and woodlands is needed. To arrive at the goal, a number of measures involving cooperation of private landowners, industries, and public forest agencies will have to be carried out:

1. Developing new uses and markets for low-quality timber.
2. Eliminating cull trees.
3. Stepping up growth rate on good-growing stock by making improvement cuttings in young stands.
4. Making improvement cuttings (1) to remove merchantable trees that are low in quality or poor risks for the future, and (2) to improve the species composition of the remaining stand.
5. Making harvest cuttings when crop trees are ready, not before, and not too long after, developing (or maintaining) where possible an uneven-aged forest.
6. Keeping livestock out of the farm woods.
7. Obtaining better protection from fire, insects, and disease.
8. Improving the system of taxing woodlands.
9. Taking advantage of all aids available to timberland owners.

10. Encouraging more public forests — for aesthetic purposes; for hunting, fishing, and other forms of recreation as well as for timber production; and obtaining the means to do a better job in public forests that we now have.
11. Practicing closer utilization in the woods and at the mill.
12. Stepping up the planting of conifers.
13. Providing more effective channels for reaching the public with the message of woodland conservation and its needs.

What is good cutting practice in one part of a woodland may be poor practice in another since stands vary according to composition, density, age, and site. The proper system of harvesting will recognize these differences and will provide for establishing new growth of the most desirable species that can be obtained under the given conditions. A strong forestry program is a bulwark for individual and national security. Better woodlands mean a better life. They mean jobs, they mean fun. Fortunately, woodlands can be used over and over, and if properly cared for will not wear out, but get better and better. Protected, and used properly, they can provide us with a fuller life now, and a brighter future. Do YOU see an opportunity, however small, for advancing the cause of woodland conservation?

APPENDIX

Note on use of terms "conifers" and "hardwoods"

The terms *conifers* and *hardwoods* are used aribtrarily in this booklet for the 2 principal groups of trees. A number of expressions are in common usage elsewhere, although, technically, the correct terms are *gymnosperms* and *angiosperms.* Sometimes the terms "softwoods" and "hardwoods" are used, particularly in the lumber industry, when the product rather than the tree is the principal consideration. Some "softwoods," however, are quite hard (eastern redcedar), and some "hardwoods" are quite soft (cottonwood), so that neither of these terms is fully satisfactory. "Broadleaves" is another term sometimes applied to the hardwoods, some of which, such as willow, have narrow leaves.

Other possibilities include "evergreen" and "deciduous," referring to the retention or shedding of leaves in autumn. The principal objection is that tamarack, which looks like an "evergreen" species nevertheless sheds its needles; and there are hardwoods in many parts of the world including California and the southern states that retain their leaves the year around although they do not look like the "evergreens."

Accepting the contradiction that hardwoods do not all have "hard" wood, the term as used here denotes those species not bearing true cones, having flat leaves broader than needles or scales, and losing their leaves in autumn. The conifers are those species which bear cones and have needle-like or scale-like leaves; with the exception of tamarack they retain their leaves over winter.

Selected References

Timber in Your Life, by Arthur H. Carhart. J. B. Lippincott Co., 1955. Possibly the best non-technical book available on current forest conservation problems and their solutions. Forceful presentation by a man of wide experience. 317 pages. Price $4.00.

American Forests Magazine, American Forestry Association, Washington, D.C. A popular-style publication; monthly. Price $5.00 per year.

Trees: The 1949 Yearbook of Agriculture. Superintendent of Documents, Washington 25, D.C. An imposing collection of information on trees and forestry. Illustrated, 944 pages. Price $2.00.

Forestry in Farm Management, by Westveld and Peck. John Wiley & Sons, Inc., New York. Second edition, 1951. Non-technical, broad coverage of farm forestry. Illustrated, 349 pages. Price $5.00.

Insect Enemies of Eastern Forests, by F. C. Craighead, formerly U.S. Bureau of Entomology and Plant Quarantine, 1950. Superintendent of Documents, Washington 25, D.C. Illustrated, index, 679 pages. Price $2.50.

Forestry, Boy Scouts Merit Badge Booklet No. 3302. Excellent material, simply presented. 36 pages, illustrated. May be obtained for 25 cents from Boy Scouts of America, 231 S. Green Street, Chicago 7, Illinois.

Bulletins for sale by Superintendent of Documents, Government Printing Office, Washington 25, D.C.

Community Forests for Rural People (1945), 5 cents.
Making Land Produce Useful Wildlife (1951), 15 cents.
The Multiflora Rose for Fences and Wildlife (1951), 15 cents.
Tree Planting in the Central, Piedmont, and Southern Appalachian Regions (1949), 15 cents.
Products of American Forests (1946), 20 cents.
Waters of Coweeta (in pictures, 1953), 20 cents.
Our Forest Resources (1954), 20 cents.
Protecting the Forests from Fire (1954), 15 cents.
In Your Service; the Work of Uncle Sam's Forest Rangers (in pictures, 1955), 20 cents.
Managing the Small Forest (1948), 15 cents.
Forestry for 4-H Clubs (1953), 25 cents.
Highlights in the History of Forest Conservation (1952), 15 cents.

On teaching forest conservation

Better Living Through Wise Use of Resources, by Halene Hatcher, U.S. Office of Education, 1950. Basic understandings, lists of teaching helps. Illustrated, 76 pages. Superintendent of Documents, Government Printing Office, Washington 25, D.C. Price 25 cents.

Conservation Education for American Youth. Report of a work conference. University Press, Ohio State University, Columbus 10, Ohio, 1950. Desirable objectives, outcomes, subject matter. Concise summary. A realistic, painstaking effort, and one of the best. 34 pages. Price .50 cents.

Teaching Conservation, by Ward P. Beard. American Forestry Association, Washington, D.C., 1948. Programs, techniques. 144 pages. Price $1.50.

Conservation Education in American Schools, 29th Yearbook of American Association of School Administrators, 1951. Objectives, methods, extensive lists of aids, addresses. Published by the Association, 1201 16th St., NW., Washington 6, D.C., 527 pages. Price $4.00.

Conservation in Camping, by American Camping Association, 1952. Results of a workshop on outdoor education held at Lake Geneva, Wis. A useful guide; activities, etc. 26 pages. Obtainable from the Association, 343 S. Dearborn St., Chicago 4, Ill. Postage charge only.

Educational Materials, U.S. Forest Service, 623 N. Second St., Milwaukee 3, Wis. A leaflet describing audio-visual and printed materials available. Free.

Bibliography of Free and Inexpensive Materials for Teaching Conservation and Resource Use, by Muriel Beuschlein. Published by National Association of Biology Teachers, 1954. This compilation has great value. Copies obtainable for 10 cents from Dr. Richard L. Weaver, P.O. Box 2073, Ann Arbor, Mich.

Handbook on Teaching Conservation and Resource Use, by National Association of Biology Teachers, 1955. Copies obtainable from Dr. Richard L. Weaver, P.O. Box 2073, Ann Arbor, Mich. Price $4.00, 20 percent discount to teachers and schools.

Trees of the Central States

(Names taken from Check List of Native and Naturalized Trees of the United States, U.S. Forest Service, 1953)

Important Species

Recognized Common Name	*Botanical Name*
Ash, black	Fraxinus nigra
Ash, blue	Fraxinus quadrangulata
Ash, green	Fraxinus pennsylvanica
Ash, white	Fraxinus americana
Aspen, bigtooth	Populus grandidentata
Aspen, quaking	Populus tremuloides
Basswood, American	Tilia americana
Basswood, white	Tilia heterophylla
Beech, American	Fagus grandifolia
Birch, river	Betula nigra
Boxelder	Acer negundo
Buckeye, Ohio	Aesculus glabra
Butternut	Juglans cinerea
Catalpa, northern	Catalpa speciosa
Cherry, black	Prunus serotina
Cottonwood, eastern	Populus deltoides
Cottonwood, swamp	Populus heterophylla
Cucumbertree	Magnolia acuminata
Dogwood, flowering	Cornus florida
Elm, American	Ulmus americana
Elm, rock	Ulmus thomasii
Elm, slippery	Ulmus rubra
Elm, winged	Ulmus alata
Hackberry	Celtis occidentalis
Hickory, bitternut	Carya cordiformis
Hickory, mockernut	Carya tomentosa
Hickory, pignut	Carya glabra
Hickory, shagbark	Carya ovata
Hickory, shellbark	Carya laciniosa
Honeylocust	Gleditsia triacanthos
Locust, black	Robinia pseudoacacia
Maple, black	Acer nigrum
Maple, red	Acer rubrum
Maple, silver	Acer saccharinum
Maple, sugar	Acer saccharum
Mulberry, red	Morus rubra
Oak, black	Quercus velutina
Oak, blackjack	Quercus marilandica
Oak, bur	Quercus macrocarpa
Oak, chestnut	Quercus prinus

Recognized Common Name	*Botanical Name*
Oak, chinkapin	Quercus muehlenbergii
Oak, northern red	Quercus rubra
Oak, pin	Quercus palustris
Oak, post	Quercus stellata
Oak, scarlet	Quercus coccinea
Oak, shingle	Quercus imbricaria
Oak, Shumard	Quercus shumardii
Oak, southern red	Quercus falcata
Oak, swamp chestnut	Quercus michauxii
Oak, swamp white	Quercus bicolor
Oak, water	Quercus nigra
Oak, white	Quercus alba
Pecan	Carya illinoensis
Poplar, balsam	Populus balsamifera
Redcedar, eastern	Juniperus virginiana
Sassafras	Sassafras albidum
Sweetgum	Liquidambar styraciflua
Sycamore, American	Platanus occidentalis
Tupelo, black	Nyssa sylvatica
Walnut, black	Juglans nigra
Willow, black	Salix nigra
Yellow-poplar	Liriodendron tulipifera

Of lesser importance

Hardwoods

Alder	Alnus — several species
Apple, prairie crab	Malus ioensis
Ash, pumpkin	Fraxinus profunda
Birch, paper	Betula papyrifera
Birch, yellow	Betula alleghaniensis
Cherry, pin	Prunus pensylvanica (one "n")
Chokecherry, common	Prunus virginiana
Coffeetree, Kentucky	Gymnocladus dioicus
Hawthorn	Crataegus — many species
Hophornbeam, eastern	Ostrya virginiana
Hornbeam, American	Carpinus caroliniana
Osage-orange	Maclura pomifera
Pawpaw	Asimina triloba
Persimmon, common	Diospyros virginiana
Plum, American	Prunus americana
Redbud, eastern	Cercis canadensis
Serviceberry	Amelanchier — several species
Tree-of-heaven	Ailanthus, altissima
Sumac, smooth	Rhus glabra
Sumac, staghorn	Rhus typhina

Conifers

Baldcypress	Taxodium distichum
Hemlock, eastern	Tsuga canadensis
Pine, eastern white	Pinus strobus
Tamarack	Larix laricina
White-cedar, northern	Thuja occidentalis

Frequently used in plantations

Pine, jack	Pinus banksiana
Pine, loblolly	Pinus taeda
Pine, red	Pinus resinosa
Pine, Scotch	Pinus sylvestris
Pine, shortleaf	Pinus echinata
Pine, Virginia	Pinus virginiana

Tree-Identification Guides

Tree Finder, Nature Study Guild, Naperville, Illinois; 25 cents. Simple and practical, with sketches of leaf-types; 3 x 5 inches, pocket size.

To Know the Trees, 52 pages, with maps of ranges, uses of wood as well as leaf sketches and descriptive keys. Superintendent of Documents, Government Printing Office, Washington 25, D.C.; 15 cents.

Ohio Trees, Agricultural Extension Service, Ohio State University, Columbus, Ohio; 15 cents.

50 Trees of Indiana, Department of Forestry and Conservation, Purdue University, West Lafayette, Indiana; free to Indiana teachers.

Forest Trees of Illinois, Division of Forestry, Department of Conservation, Springfield, Illinois; free to Illinois teachers.

Principal Forestry Agencies and Organizations

Federal

U.S. Forest Service, Department of Agriculture

Regional headquarters: 623 N. Second St., Milwaukee 3, Wis. Forest Supervisors' headquarters: Harrisburg National Bank Bldg., Harrisburg, Ill.; Stone City National Bank Bldg., Bedford, Ind. District Rangers: Ohio — Athens and Ironton; Indiana — Brownstown and Tell City; Illinois — Elizabethtown, Jonesboro, Vienna.

Central States Forest Experiment Station headquarters: 111 Old Federal Bldg., Columbus 15, Ohio. Field research centers: Iowa State College, Ames, Iowa; Southern Illinois University, Carbondale, Ill.; Ohio University, Athens, Ohio. Experimental Forests: Amana, Iowa; Elizabethtown, Illinois; McArthur, Ohio.

State

Iowa Conservation Commission, Division of Lands and Waters, East 7th and Court Sts., Des Moines 9, Iowa. Service (Farm) Foresters: Anamosa, Fairfield, Adel, McGregor, Albia.

Illinois Department of Conservation, Division of Forestry, 303 E. Monroe St., Springfield, Ill. Service (Farm) Foresters: Cambridge, Harrisburg, Charleston, Jerseyville, Sparta, Carthage.

Indiana Department of Conservation, Division of Forestry, 311 West Washington St., Indianapolis, Ind. District Foresters: Auburn, Medaryville, North Vernon, Jasonville. Service (Farm) Foresters: Bluffton, Medaryville, Versailles.

Ohio Department of Natural Resources, State Office Bldg., Columbus 15, Ohio. Service (Farm) Foresters: Defiance, Findlay, Ashland, Alliance, Burton, New Philadelphia, Cambridge, Athens, Chillicothe, Portsmouth, Piqua, Lebanon, Delaware.

Extension Foresters: Iowa State College, Ames, Iowa; University of Illinois, Urbana, Ill.; Purdue University, West Lafayette, Ind.; Ohio State University (Agricultural Experiment Station), Wooster, Ohio.

Industrial and Trade Organizations

American Forest Products Industries, Inc., 1816 N St., NW., Washington 6, D.C.

American Walnut Manufacturers Association, 666 N. Lake Shore Dr., Chicago 11, Ill.

American Paper and Pulp Association, 122 E. 42nd St., New York, 17, N.Y.

American Pulpwood Association, 220 E. 42nd St., New York 17, N.Y.

Fine Hardwood Association, 666 N. Lake Shore Dr., Chicago 11, Ill.

National Lumber Manufacturers Association, 1319 18th St., NW., Washington 6, D.C.

Congress of Industrial Organizations, 718 Jackson Place, NW., Washington 6, D.C.

Citizens Organizations

American Forestry Association, 191 17th St., NW., Washington 6, D.C.

Forest Conservation Society of America, 2144 P St., NW., Washington 7, D.C.

Forest Products Research Society, Box 2010, University Station, Madison, Wis.

Illinois Technical Forestry Association, Inc., 121 Capitol Bldg., Springfield, Ill.

Izaak Walton League of America, 31 N. State St., Chicago 2, Ill.

Ohio Forestry Association, Southern Hotel, Columbus 15, Ohio.

Society of American Foresters, Mills Bldg., 17th St. and Pennsylvania Ave., NW., Washington 6, D.C.

Wilderness Society, 2144 P St., NW., Washington 7, D.C.

Conservation Education (summer camps and other information)

Iowa — H. Seymour Fowler, Iowa State Teachers College, Cedar Falls.

Illinois — Byron K. Barton, State Dept. of Public Instruction, Springfield.

Indiana — Howard H. Michaud, Dept. of Forestry and Conservation, Purdue University, West Lafayette.

Ohio — Robert R. Finlay, State Dept. of Education, Columbus.

Fire control on state and private lands

Iowa is divided into 3 fire-protection districts which cover the eastern and southern parts of the state. An officer whose duties include administering a state forest serves as fire-control chief for each of these large districts. Headquarters are in McGregor, Farmington, and Chariton. Within each district there are from 9 to 16 volunteer fire wardens who are depended upon to go to fires. Thirty park custodians, whose duties include administering state parks, serve also as fire wardens and have park workers and equipment available for taking action on fires.

Illinois has 4 administrative districts, each headed by a district forester of the Division of Forestry, who is responbile for fire protection, forest management assistance to landowners, and other forestry activities. One of the state forester's staff assistants coordinates fire-control efforts statewide. District foresters are assisted by 9 district fire wardens who direct and perform the fire-control work. There are 8 state-employed fire lookouts who man the fire towers. These men are assisted by organized community fire-fighting groups; at times, emergency fire fighters are employed. Service (farm) foresters also help with fire control during hazardous periods. Most of the fire control work in Illinois is concentrated in the southern third of the state.

Indiana has an organization in which fire control is operated as a more or less independent unit within the Division of Forestry. It differs in this respect from the other 3 states, where fire control is not organized separately. One of the state forester's staff assistants, the state fire chief in Indianapolis, heads up the fire-control organization of 5 district fire wardens and their 22 assistants. District fire wardens are located in Ferdinand, Jasonville, Martinsville, Henryville, and North Vernon, all in the southern half of the state. During fire weather, 27 lookout towers are manned. Two patrol planes are under contract, and a radio communication system is in operation. Two service (farm) foresters are responsible for fire protection in northern Indiana. Training of young people in the Forest Fire Fighters' Service is discussed on pages 70 and 71.

Ohio is divided into 4 forest districts. A district forester responsible for over-all forestry work is in charge of each district. Headquarters for the forestry districts are Chillicothe, Athens, New Philadelphia, and Findlay. One of the state forester's staff assistants acts as fire chief and coordinates fire-control work statewide.

Direct action on fires is usually first taken by a local resident who is a commissioned volunteer fire warden. Contact with these men is maintained by 12 area fire wardens who are part of the regular forestry organization. The area wardens in turn are responsible to division wardens on the staffs of the district foresters. Three of the district foresters also have special fire-control assistants. In the state forests in Ohio, the 20 rangers in charge are responsible for fire protection within their units. Ohio operates 39 lookout towers, 4 planes, and has 2 additional private planes under contract. Equipment includes 112 2-way radios, 60 trucks, 4 tractor plows.

Fire control on national-forest lands

Nearly ½ million acres of national-forest land is protected by the U. S. Forest Service in Illinois, Indiana, and Ohio. State and private lands are so intermingled that all fire-control organizations — federal, state, and local community — work in close coordination. There are 3 national forests; headquarters are given in the Appendix on page 121. At national-forest headquarters in Bedford and Harrisburg, assistant supervisors serve as staff fire-control officers.

Forest-fire protection is part of the district ranger's administrative duties in connection with managing national-forest land. The ranger's fire-control aides are a dispatcher, a fire guard, and lookouts. The dispatcher receives reports of fires by radio or telephone at the communications and supply center at ranger headquarters. He sends men, equipment, and supplies to fires and coordinates the action. The fire guard carries on prevention work, trains lookouts and wardens, and goes to fires either as a fireman alone, or as a foreman in charge of a crew.

Rangers place a great deal of reliance for fire fighting upon their planting crews. A volunteer organization of about 10 men per district serve as fire wardens, initial action on fires in their respective neighborhoods, and authority to hire additional help. The volunteer wardens are paid when actually employed on fire duties. The U. S. Forest Service maintains 15 towers in Illinois, 7 in Indiana, and 7 in Ohio.